

THE JOURNAL
OF
THE DEPARTMENT OF AGRICULTURE,
VICTORIA, AUSTRALIA.

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DEPARTMENT OF AGRICULTURE, VICTORIA**RED POLL DAIRY HERD****YOUNG BULLS FOR SALE**

TO VICTORIAN DAIRYMEN

DAM.	Date of Birth.	RECORD OF DAM.				PRICE.
		Milk lbs.	Average Test.	Fat lbs.	Butter lbs.	
Sired by "NICOTINE" by ACTON DEWSTONE (imp.)						
Havana	... 17.8.14	6365	4·15	264·3	301 $\frac{1}{4}$	13 Guineas
Kentucky	.. 21.8.14	7905	3·96	313·3	357 $\frac{1}{4}$	15 ..
Connecticut	... 3.4.15	6780	5·36	364·0	415	18 ..
Vuelta	... 25.4.15	7750	6·24	485·1	553	24 ..
Cameo	... 28.5.15	5454	5·15	281·2	320 $\frac{1}{2}$	14 ..
Sumatra	... 24.5.15	9062	4·67	423·4	482 $\frac{1}{4}$	21 ..
Sired by "GANYMEDE" by HONINGHAM ALAKE (imp.)						
Laurel	... 12.12.14	Heifer.	No Record.			5 ..
Ontario	... 18.12.14	..	..	..		5 ..
Sired by "THE SPANIARD" by ACTON DEWSTONE (imp.)						
Marcia	... 22.5.15	Heifer.	No Record.			5 ..

The prices are based approximately on the actual milk and butter fat record
of the dam at the rate of 1s. per lb. of butter fat yielded.

For History and Record of the Herd see *Journal of Agriculture, September, 1914.*

**Calves under six months old may be purchased
for delivery at that age.**

**Inspection by arrangement with Mr. E. STEER, Herdsman,
Central Research Farm, Werribee.**



THE JOURNAL OR The Department of Agriculture OF VICTORIA.

Vol. XIII. Part 7.

10th July, 1915.

REVIEW OF THE VICTORIAN DAIRYING SEASON, 1914-15.

By R. Crowe, Exports Superintendent.

Upon nearly every occasion on which I had the privilege of addressing you I felt it was my duty to sound a word of warning through you to the dairymen of the State regarding the advisability of making provision for the feeding of the dairy cows during periods of scarcity. Unfortunately the optimistic opinion of this time last year concerning the prospects for the season just ended did not materialize, and Victoria is just now emerging from one of the most disastrous droughts ever experienced. The most provident amongst us could not anticipate a visitation of such an extraordinary and general character. There was a universal shortage of fodder both for horses, cattle, and sheep here as well as in some other States. No one could have foretold the length or severity of the drought or be expected to make full provision for such an unusual occurrence. Producers are therefore entitled to every sympathy on this occasion. One cannot but hesitate to ponder on, or attempt to estimate the extent of, the mortality amongst stock of all descriptions. The death of cattle is bound to still continue for some time to come through lowness of condition and cold weather. It was indeed fortunate that the export trade in meat and the facilities for cold storage provided an outlet for tens of thousands of stock which otherwise must have perished for want of food. Of course the particular animals slaughtered may not have died, but if not so dispersed of much more than an equal number would have been displaced and lost.

The slaughter of thousands of head of dairy cows and young dairy heifers for beef purposes during the past season must seriously impair the future of the dairy industry for many years to come. You would be well advised now to use your best influence in assisting to build up to its former standard our great dairy industry. At the present moment no better way of directing your efforts could be suggested than

by using your powers to the utmost in preventing the wholesale destruction of suitable dairying heifer calves. It is only by such means that our dairy herds can again be quickly replenished.

The question of fodder conservation is all the time of pre-eminent importance, and it is sincerely to be trusted that ample provision for stock feeding in periods of scarcity will be generally adopted. Were it not for the fact that large areas of land had been devoted to irrigated agriculture for the growing of lucerne and other fodder crops, the northern parts of the State would have been practically decimated of stock. One could hardly credit the enormous carrying capacity of comparatively small areas of this land when under irrigation. On one particular area of about 14,000 acres, only some of which was irrigated, there were grazing at one time 14,000 sheep, 2,000 horses, and 1,900 head of dairy stock. Other farms were leased for terms of seven or eight months for a rental of up to £10 per acre. Unfortunately, owing to the unusually low rainfall on the one hand, and the increased demand for water for irrigation on the other, the supply practically gave out, and these veritable oases became non-productive for the time being.

What the value of such irrigated areas, in maintaining stock in good condition and checking mortality, would have been to the State had there been a sufficiency of water for irrigation purposes is hard to conceive. The losses would have been immensely reduced. The failure of our water supply for irrigation purposes towards the end of the season may then be regarded as a national calamity, as it not only concerned the users of water, but the whole community. The blame for such failure cannot be justifiably laid at the door of any body or individual. The length and severity of the visitation were unprecedented. The experience, however, should so strongly emphasize the necessity for better conservation of water as to make a like recurrence impossible.

BUTTER PRODUCTION.

The exports for the season compare with the two previous years as follow:—

1914-15 ..	6,585 tons, 134/- ..	£882,390
1913-14 ..	13,004 " 115/- ..	£1,495,460
1912-13 ..	12,686 " 120/- ..	£1,519,146

The average weekly production at the moment is 50 tons, or only 20 per cent. of the requirements of consumers in this State. The total receipts of butter in Melbourne for the week ended 1st of this month was only about 2,000 cases, compared with over 6,000 for the corresponding week of 1914, and 13,000 for the same period for 1913. Unlike previous years, when supplies to make up the deficiency were obtained from the northern States, production in those places is now barely sufficient for local requirements, with a diminishing tendency, so that it looks as if a partial butter famine was imminent through the cessation of supplies from other States.

To relieve the situation, a section of the community has resolved to refrain from eating any butter for a month (according to reports in Monday morning's papers). It is most commendable that a body of consumers should in this way sacrifice themselves for the benefit of the rest. It probably costs the dairy farmer, through no fault of his own,

about double the money to produce each pound of butter at the present time as the current market price. The local dairyman who has been supplying my family with milk at 5d. per quart ceased to do so yesterday, and has gone out of the business to try and get work somewhere else. He has been losing money for some time past, and gradually exhausted his resources. Fivepence a quart equals 1s. 8d. a gallon, and, as it takes $2\frac{1}{2}$ gallons of milk to make 1 lb. of butter, the producer's position can be imagined.

Since the advent of the export trade consumers have been particularly fortunate in the rate at which they have had their butter supplied them. I can recollect only one occasion when the wholesale price went up to 2s. 3d. per lb. It was in June, 1892, and the cash retail price went up to 2s. 6d. per lb. Prior to the beginning of the export business in the eighties, it was a common occurrence for the price to reach 2s. 6d. per lb. during the autumn and winter months. Judging by the present prospects there is no probability of butter forthcoming in sufficient quantity to fully supply the local demand before next August. The more one studies matters, it is recognised that this is a continent of incongruities. When an industry shows signs of languishing, it is considered, in the opinion of some people, that support and encouragement are necessary for its resuscitation and development, but if it be a rural industry, the principle apparently is not held to apply—for what reason is not understandable. The way to make butter cheap, according to the line of reasoning just quoted would be by giving more remunerative prices for the product, thus encouraging increased production, and by inducing more people to embark in the industry; but no, this principle, in the minds of a certain section of the community, should be made to apply to city or manufacturing industries only. Further comment is needless.

Quality.—The average grade of all butter examined for export for the season was 90.088 points compared with 90.47 for 1913-14. The following are particulars:—

9·67%	superfine against	8·94%	for 1913-14.
57·68%	1st grade against	64·89%	for 1913-14.
28·89%	2nd grade against	23·20%	for 1913-14.
3·59%	3rd grade against	2·65%	for 1913-14.
0·19%	pastry against	0·32%	for 1913-14.

Although showing a slight improvement in the percentage of superfine the total above the minimum for first-grade quality is over 6 per cent. lower than for the previous season; or, in other words, there was 6 per cent. more second and third grade butter exported than for the season before.

This gradual levelling down to the lower grades is, to say the least of it, undesirable from the point of view of the future of the industry, and, unless rectified, will, I feel sure, be reflected in the prices received for our butters in the London market with the return of normal conditions.

Weights.—Twenty-three consignments, representing 717 boxes, were intercepted from shipment on account of short weight. By checking these packages, 640 were passed as correct, the remaining seventy-seven having had their contents amended under supervision before export.

This compares with twenty-three consignments, representing 1,123 boxes, of which thirty-six were short in 1913-14.

Twenty-eight consignments, representing 1,201 boxes, were found to have both short and bare weight boxes. On checking these, 955 were passed as correct. Of the remaining 246 boxes, ninety-five were found to be short weight, and 151 bare weight. They were made up and released.

In season 1913-14 there were forty-two consignments similar to above—202 were short and 403 bare weight.

Forty-eight consignments, representing 2,812 boxes, were found to contain "Bare weight" boxes, and not so marked. In forty of these consignments, 123 boxes were brought up to correct weight—the remaining eight consignments, representing 1,339 boxes, were indelibly impressed with the words "Bare Weight." This compares with seventy-two consignments for season 1913-14.

Fifty-seven factories were out of bounds as regards weight, as compared with sixty-eight for season 1913-14.

Moisture.—Thirty-six consignments, representing 632 boxes, containing more than 16 per cent. moisture, were withheld from shipment until percentage was reduced. This compares with twenty-five consignments aggregating 568 boxes for season 1913-14.

The average per cent. of moisture in samples analyzed was 14.37, as compared with 14.06 for 1913-14, and 13.91 for 1912-13.

Twenty-nine factories offended against moisture as against twenty-one in 1913-14.

Butter Fat Contents.—Two consignments, representing twenty boxes, were deficient in butter fat, and were re-worked to comply with standard. This compares with the same number of consignments in 1913-14.

Salted and Unsalted.—Season 1914-15 up to 30th April, 1915:—Percentage of salted butter shipped, 62.93; percentage of unsalted butter shipped, 37.07.

Condemnations.—Two consignments, representing sixteen boxes, were, on examination, found to be unfit for human consumption—they were seized. This compares with three consignments in season 1913-14.

Quality.—The conditions prevailing, both here and in London, of late years, have lulled butter-makers into a false sense of security as regards quality. Good and uniform prices have been obtained for almost any quality of butter, thus naturally providing an incentive for relaxation in the care of and grading of the cream and the manufacture. With a return to normal conditions, both here and abroad, those engaged in the dairying industry will receive a rude awakening, unless some practical steps are taken to stop the present tendency in regard to prices in relation to the quality of our butter. The margarine manufacturer is abroad, and prosecuting an energetic campaign when the conditions are so favorable. Many consumers, owing to the exigencies of the war and the high price of butter, find themselves in the position of being unable to purchase butter, and must resort to margarine. Owing to the great improvement that has taken place in the manufacture and preparation of margarine, it is reasonable to conclude that a considerable proportion of those consumers will be captured by the margarine manufacturer to the detriment of the butter trade. Quality is our only safeguard in this matter, and relative price should be an essential corollary, and upon these depend the future of dairying and the successful settlement of our country. No other industry can take the place of dairying, and consequently it must be regarded as an important national asset. Poor quality should mean reduced prices,

which, in turn, reduces the value of land, and stock, and labour, thus every one of us is interested, and we should all unite in an effort to place dairying on a more satisfactory basis. By securing relatively high prices for good quality butter, an incentive is given to produce an improved article. During recent years, unfortunately, it has been more profitable; in other words, it paid better to manufacture a medium or poor quality of butter than a high class article. The difference in price between the two was not sufficient to warrant a continuance of the increased cost involved in the production of a superfine product. It costs more to deliver or collect cream at frequent and regular intervals, and pasteurize and cool it, than to have it dealt with in a slipshod manner, and when the difference in price proves insufficient to warrant a continuance of the additional outlay, it is only a matter of time when it is dropped.

UNIFORM BUTTER GRADING.

The question of uniformity of grading throughout the Commonwealth has been exercising the minds of the authorities for some months past. There was no wide divergence of opinion in regard to what constitutes the various grades of butter as prescribed by the Commerce Regulations. The Senior Inspector of Dairy Produce, Mr. P. J. Carroll, was deputed to attend a conference of graders in the State of New South Wales in August last. New South Wales, Queensland, and Victoria were represented at that conference, and after carefully grading numerous samples of butter, it was found, on comparing results, that only in a few instances were there any differences in the actual grade of the butter. After discussion and a further re-examination of these particular butters, it was concluded that, as far as flavour was concerned, the standard of the different States was uniform. In Queensland and New South Wales the standard for texture and condition was on a more strict basis (particularly the latter State) than Victoria. The delegates agreed that, in order to bring about greater uniformity under these two headings, New South Wales and Queensland should relax slightly, and that Victoria, to meet this alteration, should adopt a higher standard for texture and condition. This fact is mentioned so that you may be prepared to meet the amendment by the adoption of a higher standard in the manufacture and get-up of your butter in future; although all the time, regarding flavour as the prime essential in butter, no maker or factory manager should risk the grade of his butter by adopting or permitting slipshod methods in manufacture. With this slight alteration in the grading under the headings of texture and condition, no necessity is seen for any drastic amendment in the present standard of points under which butter is graded. Any variation in the present basis of grades, which has been continuous in this State for nearly twenty years, would lead to a good deal of confusion amongst manufacturers and London purchasers. Fundamentally, the system is sound. It is universally recognised, and any material alteration would mean sacrificing the confidence earned of all parties concerned.

TECHNICAL INSTRUCTION.

With the almost universal adoption of the home separator throughout the State, the conditions of butter-making have very materially changed, and the lot of the factory manager during the transition stage is not

an enviable one. The dairymen themselves are not educated in the manner of caring for their cream, and the practice of irregular delivery is making serious inroads into the quality of our best factories' butters. The adoption of pasteurization and neutralization, which has been successfully undertaken by some of the factories, is worthy of serious thought and further extension. Departmental officers will be available, in the slack season of the year, at any rate, to render what assistance they can to factory managers who desire information on these and other matters. The present condition of the industry, however, warrants whole-time instructors, as, when instruction is most needed, the present staff are otherwise occupied. If we are to maintain our position here, in Victoria, as butter producers, in comparison with other States and New Zealand, some practical steps will require to be taken, and that promptly, to improve the present quality of many of our factories. Directors and managers can do their share by organizing methods for the frequent collection of cream, without which no amount of instruction will ever achieve the end desired. Given a good system of cream collection, and intelligent application of the means at our disposal in the factory, there is no reason why the product of Victorian factories should not touch as high a level as it did prior to the advent of the home separator.

SCIENTIFIC INSTRUCTION.

The following syllabus, drawn up by the Department of Agriculture and the University authorities, is tentatively submitted for consideration, and will in itself convey the scope of the proposed instruction. On account of the past disastrous season it cannot be hoped that it will be adopted at once, but with the hope of better seasons ahead this phase of the factory manager's education must not be lost sight of.

Class for the Scientific Instruction of Butter Factory Managers.

A class for the scientific instruction of butter factory managers will be held at the University and one of the Melbourne butter factories during June and July, commencing on Monday, 14th June, and ending on Friday, 6th August.

The University work will comprise:—

- (a) Lectures and laboratory work on the chemistry of milk and its products, by Dr. Rothera.
- (b) Demonstrations and laboratory work in the practical bacteriology of the dairy and factory, by Dr. Bull.
- (c) Lectures on dairy farming in relation to the factory supplies, by Professor Cherry.

The butter factory work will include lectures, demonstrations, and factory practice by Messrs. Archer and Carroll.

The course will also include practical demonstrations in dairy farming, management of the herd, and handling of the milk at the Central Research Farm, Werribee.

With regard to the practical work to be undertaken, the drawing up of a time table has been deferred until the Managers' Association was consulted, and the Association is asked to give special consideration to this matter in consultation with Messrs. Carroll, Senior Inspector Dairy Produce, and Archer, Senior Inspector of Dairies.

BEE-KEEPING IN VICTORIA.

By F. R. Beuhne, Bee Expert.

(Continued from page 304.)

XXVI.—THE HONEY FLORA OF VICTORIA—*continued.*

GIPPSLAND Box (*Eucalyptus Bosistoana*).

(Fig. 23.)

A tall tree running up to over 150 feet with a stem diameter of 3 to 4 feet. The bark is rough on the trunk at the base, but smoother towards and on the branches. The leaves are mostly narrow lance-shaped, but variable in shape on the younger trees; they are generally dull green on both sides, the veins are faint, rather far apart, the marginal vein removed from the edge of the leaf. The leaves of young seedlings are roundish or egg-shaped, stalked and scattered on the stem. The umbels are few-flowered, and at the shoulders of leaves; the buds are egg-shaped, with a pointed lid. The fruit is comparatively small, nearly half-egg-shaped, with five to six, rarely four cells, and a narrow rim.

The wood is close-grained, brownish to yellowish-white in colour, and very durable; it is used for piles, railway sleepers, bridge-decking, wagon-frames, spokes, felloes, and fence posts.

This tree is in Victoria confined to the eastern parts, occurring chiefly in the Bairnsdale district. It is known by various local and confusing names, such as box, bastard box, grey box, and yellow box.

Pollen is gathered from the blossoms by bees, the flowering occurring generally in February. Owing to its flowering concurrently with other eucalypts in the same locality, no data are yet available of the amount and the character of the honey obtained from it.

THE GIANT GUM TREE.

(*Eucalyptus regnans*.)

Fig. 24.

This tree is closely allied to the Narrow-leaved Peppermint (*Eucalyptus amygdalina*), it is known as Blackbutt, Mountain Ash, and even White Gum. In Victoria it occurs over a wide area in South and Western Gippsland together with Messmate (*E. obliqua*), and Blue Gum (*E. globulus*).

It is the largest tree in Australia, trees over 300 feet high being known in Victoria. It was formerly held to be of much greater height, as much as over 400 feet: authoritative measurements have, however, since reduced it to somewhat over 300 feet.

The following description is extracted and the illustration (Fig. 24) taken from Mr. J. H. Maiden's *Forest Flora of New South Wales*.

The mature leaves are lance-shaped to broad lance-shaped, thinning on both sides, usually thin in texture (but sometimes quite leather-like), veins slightly spreading, oil dots extremely numerous. A common method of recognising *E. regnans* is to hold up a leaf to the light and to notice the fine oil dots which cover its surface, but this characteristic is possessed by the leaves of a few other species.



Fig. 23.—Gippsland Box (*Eucalyptus Borsigiana*, F.v.M.).

The juvenile leaves of young seedlings are broad, lance-shaped, and opposite, but soon become scattered on the stem and broad lance-shaped unequal-sided, pointed very like those of Messmate (*E. obliqua*) saplings. The buds are rounded to pointed conical in clusters occurring singly or in pairs. The fruits are variable in size and shape, the stalk of the cluster is often an inch long.

The bark is more or less fibrous in the under layers on the butt of the trunk. On the giant trees there is very often little of this bark, the upper portion resembling a White Gum. On other trees of the same species the fibrous bark runs further up the trunk, and thus it follows that the same species may locally be called either a White Gum or a Blackbutt.

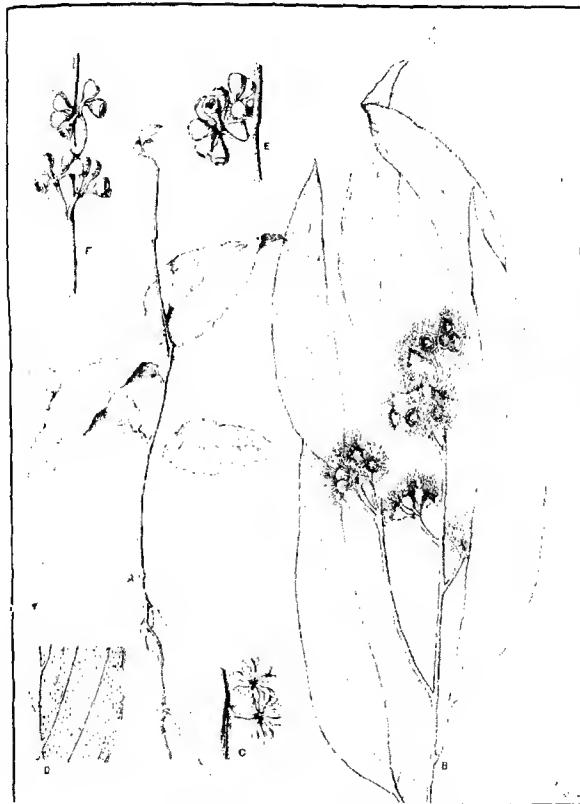


Fig. 24.—The Giant Gum Tree (*Eucalyptus regnans*, F.v.M.).

The timber is pale coloured, very fissile (free in grain) and therefore well adapted for palings, shingles, and fence rails; it is also extensively used for saw-mill purposes.

As to the value of the Giant Gum for bee-keeping purposes, nothing is known, as it occurs in districts where commercial bee-keeping is not yet carried on, and therefore no observations have been made as to the

amount and character of the honey, and whether it furnishes pollen for bees; but it is probable that in this respect it resembles the closely-



Giant Forest Tree in Victoria.
Giant Gum Tree (*Eucalyptus regnans*), Narbethong, Vic.

allied species *E. amygdalina* (Narrow-leaved Peppermint) and *E. dives* (Broad-leaved Peppermint).

THE NARROW-LEAVED PEPPERMINT (*Eucalyptus amygdalina*).

(Fig. 25.)

The peppermint eucalypt of Victoria, New South Wales, and Tasmania, occurring in Victoria on the poorer soils, in the cooler districts. In some localities it is known as "Messmate," from which, however, it is



Fig. 25.—The Narrow-leaved Peppermint (*Eucalyptus amygdalina*, Labl.).

very easily distinguished and in the company of which it often grows. *Eucalyptus amygdalina* is the tree from the leaves of which most of the commercial eucalyptus oil is distilled.

A tree usually small or moderate-sized, but sometimes attaining considerable height, the bark is fibrous on the trunk and larger branches,

but usually smooth higher up. It is grey or brownish-grey in colour, and not so fibrous as that of stringybark.

The leaves are narrow, long lance-shaped, sharply pointed, rather thin; the veins are few and oblique, not prominent; usually the foliage is dense and drooping; the buds are short-pointed, generally very numerous in the umbels; the fruit small, with a flat or slightly concave rim.

The peppermints, of which there are several, are readily distinguished from other eucalypts by the strong peppermint odour of the leaves when bruised.

The wood is pale-coloured (nearly white) when newly cut, but dries to a pale brown, it often contains gum veins, is of inferior durability, but occasionally used for fence posts and shingles, and makes fair fuel.

The narrow-leaved peppermint blossoms from October to December, practically every year, and rather profusely, but it does not appear to be of much value to the beekeeper. In the writer's experience of twelve years' beekeeping in peppermint country it never yielded enough nectar or pollen to be noticeable in the hives, and the yields of peppermint honey sometimes reported were probably obtained from other eucalypts called peppermint in that locality.

In the Beechworth district, however, it sometimes yields well. The honey is not first class, and candies quickly and very hard.

THE BROAD-LEAVED PEPPERMINT.

(*Eucalyptus dives.*)

Fig. 25.

A tree of medium size, but often flowering as a tall shrub, occurring in Victoria chiefly in the North-Eastern portion, and in a dwarfed state on part of the outer fringes of the Grampians. It closely resembles the Narrow-leaved Peppermint (*E. amygdalina*), together with which it grows in some localities. The leaves are generally broader than those of the latter; the chief distinguishing feature, however, is the sucker leaves, which are quite narrow in one and broad in the other, as will be seen on reference to the illustrations (Figs. 25 and 26). Generally speaking, the Broad-leaved is more aromatic than the Narrow-leaved Peppermint the odour different, though difficult to describe, and the fruits are usually larger.

The leaves are broadly lance-shaped, nearly symmetrical, and usually rather thick, the veins spreading and conspicuous. The buds usually blunt, but not distinctly rounded. It is a profusely-flowering species, with clusters of eight to twelve and even more flowers. The fruits are sometimes nearly half-round, or more or less inclined to pear shape.

The timber is pale-coloured, full of gum veins, and almost useless excepting for fuel.

This tree is known also as Peppermint, Blue Peppermint, and in the North-East of this State as Messmate.

As a honey-yielding tree it does not rank very high; like the Narrow-leaved Peppermint, it is so far reported as nectar producing only from the North-Eastern District.

The honey is somewhat paler than that of the Narrow-leaved Pepper-mint, which, however, may be due to admixtures of honey from other

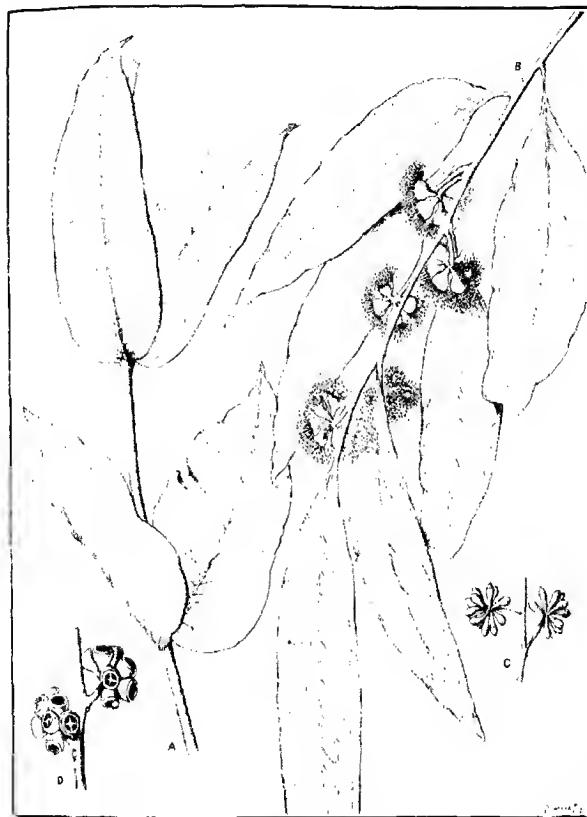


Fig. 26.—The Broad-leaved Peppermint (*Eucalyptus dives*, Schauer).

sources. It candies quickly. No information is available as to whether it yields pollen for bees.

(To be continued.)



TOBACCO BEDS FOR BLUE MOULD.

By Temple A. J. Smith, Tobacco Expert.

Make cold frame for beds by putting 6-in. or 12-in. hardwood boards on edge round the area selected, which should be a rich patch of sandy loam or well-drained soil of good quality. Form the beds 3 feet wide, and any convenient length. A bed 3 feet wide and 10 feet long should provide plants sufficient for 2 acres, though careful growers generally sow two or three times this area to have a plentiful supply.

A useful-sized plot for, say, 9 acres of plants would be 18 feet by 30 feet. This makes a convenient size for five beds 30 feet long and 3 feet wide, with paths of 1 foot in width between each bed. Canvas and cheese-cloth coverings also fit in well to frames of these dimensions.

The soil should be worked to a depth of 4 inches, and brought into a very fine tilth, all roots and stones or rough material being removed during the process, as the seed, being very small, requires a fine seed-bed.

Some growers believe in burning wood or litter of any description on the surface of the plot before working it up to destroy the larvæ of insects, and also any seed of weeds in the soil, and the system is a good one.

Where the disease known as "Blue Mould" is prevalent, the following treatment has proved highly beneficial:—

After the beds have been worked in the manner described, the surface soil to a depth of 3 inches should be turned back, and 1 lb. of unslacked lime spread on the bottom to each square foot of surface.

On the lime $\frac{1}{4}$ oz. of carbolic acid crystals to each square foot should be sprinkled, and the soil replaced on top of the lime and crystals.

The bed must then be watered with a solution containing 1 lb. of carbonate of potash and 1 oz. of bluestone dissolved in 40 gallons of water, this amount sufficing for 30 feet of beds.

The bed should immediately after watering be closely covered with old bags, tarpaulins, or any material that will keep the heat and fumes in the soil.

The effect of the mixture is to thoroughly fumigate the soil to a depth of 4 inches, killing all fungoid germs and insect larvæ. A considerable heat is generated owing to the action of the lime, acid, and water. As soon as the bed cools down, the soil should be thoroughly mixed with the lime, and sown before it has become actually cold.

The seed should be mixed with dry sand or powdered ashes, and sown on the surface of the beds at the rate of 1 oz. of seed to every 50 square yards. This is fairly heavy seedling, and with good heavy seed half this amount is often sufficient. The seed having been sown on the surface, and pressed into the soil with a board, or lightly brushed in with a soft broom, the beds should then be covered with cheese-cloth or light open hessian, which is stretched across the top of the frame of hardwood, and prevented from sagging on to the soil by the insertion of pegs every 6 feet, or battens placed across the frame about the same distance apart.

The beds should be kept moist, but not wet, especially during the early stages of growth, and watered with a light rose, or sprinkler, so as not to wash the seed off the beds into the paths.

Before transplanting, the plants should be hardened by exposing them to the sun by turning back the cloth covering for an hour or two each day for three or four days. This is best done in the mornings before the sun gets too much power, especially for the first time or two.

Weeds should be kept out of the beds, and if the plants come too thickly they should be weeded out, the intention being to allow each one as nearly as possible a square inch in which to develop.

The system advocated has proved so satisfactory during the two years' trial given that it can be safely recommended as a great preventive, if not a cure, for blue mould; beds so treated not only were free from the disease, but were not affected by insects, and the plants grew quicker and better, while all the beds round them died off and were failures.

There can be no doubt that the addition of lime to the soil is beneficial, also the potash, both of which are essential for successful tobacco growing.

The covering of the beds with cheese-cloth is also a great improvement on the old open-bed system. Less watering is required, and a more regular temperature preserved, danger from frost is avoided, and moths and other insect pests kept out.

A further advantage in growing plants under a cold frame exists in the fact that, should mould appear, the temperature under the covering can be raised to 80 or 90 degrees F. by using hurricane lanterns, which has the effect of preventing the spread of the disease. Care must be taken not to raise the heat over 90 degrees F., or the plants will scald, and anything over 80 degrees F. is sufficient to kill the spores of the disease.

The whole cost of this treatment is very slight, and less labour is required to weed and prepare beds, as a lesser area is sufficient. The hardwood boards will last for many years, but the cloth covering will require to be renewed every second season.

The same site can also be used for many years, and will even improve under good management, which means rational manuring with farm manure and artificial fertilizers.

SOIL TEMPERATURE.

AN IMPORTANT FACTOR IN SCIENTIFIC AGRICULTURE.

By L. B. Pritchard, B. Agr. Sc. Field Officer.

The successful propagation of plant life depends upon many favorable conditions being present in the soil, and by no means least among these is soil temperature.

Before the vital processes involved in growth become active a certain temperature is necessary, which, according to most authorities, lies between 40° F. and 45° F. for the plants comprising the ordinary farm crops, while it is generally accepted that a temperature of 41° F. is necessary for the beginning of vegetative growth.

Soil temperature is one of the essential limiting factors of plant growth; it affects three important functions in the soil, e.g., the biological, chemical, and physical functions.

The biological function comprises—

- Germination.
- Maximum growth of the plant.
- Osmotic absorption of moisture by the roots.

The chemical function comprises—

- The acceleration of all chemical actions.
- The solvent action of water.
- Osmotic pressure; a rise of temperature increases the osmotic pressure.
- Formation of nitrates; favoured by heat.
- The weathering of rocks.
- Decomposition of organic matter.

The physical function comprises—

- The movement of soil moisture as influenced by changes in temperature.
- The movement of the air.
- Disintegration of rocks; expansion and contraction due to changes in temperature.

The connexion between soil temperature and vital processes is most apparent in the case of "germination," for which not only is a certain minimum temperature necessary, but for several degrees above this minimum germination may be so slow and irregular that the young plant is liable to perish while remaining in such a critical condition. That is to say, there is also a certain optimum temperature, generally several degrees above the minimum temperature, at which germination will take place most favorably, and at which temperature the subsequent vital processes will proceed to form a healthy plant.

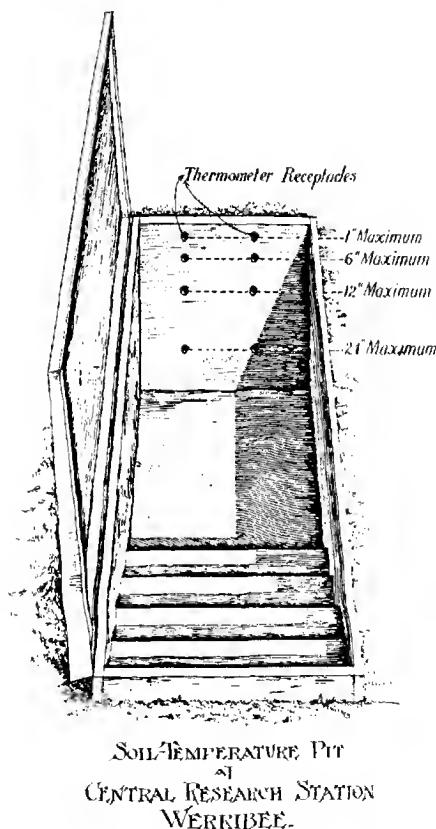
The following table, as compiled by A. D. Hall in *The Soil*, p. 125, shows the range of temperature for the germination of various cultivated plants:

TEMPERATURES OF GERMINATION.

		Fahrenheit.		
		Minimum.	Optimum.	Maximum.
Wheat	.. .. ..	32-41	77-88	88-110
Barley	.. .. ..	40	77-88	100-110°
Oats ..	.. .. ..	32-41	..	80-100°
Pease ..	.. .. ..	38-41	..	..
Beans ..	.. .. ..	49	91	115
Maize	.. .. ..	49	91	115°
Cucumber, Melon, &c. ..	.. ..	60-65°	88-90°	110°-120°

"The practical bearing of these figures is obvious. It is necessary to sow some seeds, like the melon, in heat, and to defer the sowing of other crops, like maize, until the ground has acquired not only the temperature necessary for germination, but one that will insure a subsequent rapid growth of the seedling plant."

It is well known to-day the important part played by soil bacteria in the nutrition of crops, and it is a point of some significance that the beneficial bacteria are active within about the same limits of temperature as have been indicated above for the higher plants. The nitrification bacteria, for example, cease their work below 41° F. and above 130° F., their period of greatest activity occurring when the soil temperature registers about 99° F.



The importance of soil temperature in the initial stages of the growth of plants has been dwelt upon, but the plant, once firmly established, is subject to a good deal of modification from this source also. The osmotic absorption of water by the roots of a plant is controlled by the temperature of the soil, and it may happen that the temperature of the soil becomes so low as to temporarily suspend the absorption of

water by the roots, while the aerial portion of the plant still continues to transpire water in a favorable atmosphere. If such be the case, the plant wilts, and if the action extends over any length of time, disruption of the cells takes place and the plant is killed. This is generally what happens to plants during a frost. It is not the actual cold which affects the plants, but the drying-out process which a low soil temperature produces. In such a case any protection to the plants, such as that afforded by a covering of straw, dead leaves, &c., will prevent the destruction of the plants; not, as is popularly supposed, by the plants being kept so much warmer, but simply that the evaporation from the plants is reduced to a minimum.

SOURCES OF SOIL TEMPERATURE.

Farm soil receives its heat from four sources, e.g., from—

- (1) Direct radiation from the sun.
- (2) Precipitation or condensation of aqueous vapor.
- (3) Interior of earth, by conduction.
- (4) Decomposition of organic matter.

The heat derived from the last three sources—the first two of which are entirely beyond the control of man—is very small in comparison with the heat derived from the first and greatest source, e.g., the direct radiation of the sun.

The only source to be practically under the control of man is that mentioned last, and here, again, the source of heat may be derived as the result of two operations, e.g.:—

- (a) The decomposition of vegetative matter, as occurs in the familiar practice of green manuring.
- (b) The decomposition of stable manure when applied to the soil in considerable quantities.

N.B.—Horse manure raises temperature most.

Cow manure raises temperature intermediate.

Sheep manure raises temperature least.

While these latter sources of heat have been mentioned more from the interesting than the utilitarian aspect, it may be again stated that the main source of soil heat is that derived from the radiant energy of the sun. It has been enunciated by Langley that the radiant energy received by an average seed bed of 4 to 5 inches in depth, if wholly absorbed, is sufficient to raise the temperature of that seed bed as much as 90° F. in an hour. The sun's rays, however, are not wholly absorbed by the soil, being reflected in varying degrees, according to the nature and colour of the soil. Dark-coloured soils absorb more than light-coloured soils, and well-tilled* surfaces retain their warmth near the surface, whereas the heat is conducted to the lower layers beneath an unworked soil surface.

* When a soil is cultivated the area of its surface exposed is by far greater than that of an undisturbed soil, and, necessarily, the amount of evaporation from the former is greater than from the latter. As a result of this difference in evaporation, the temperature of cultivated soil does not rise at the beginning as high as that in uncultivated soil. As soon, however, as a dry mulch is formed on the cultivated soil its loss of moisture by evaporation is reduced considerably, while the loss from the undisturbed soil is still large, and consequently its rise of temperature is small. On the other hand, the heat that is not expended on the evaporation of water is rapidly conducted downwards in the case of uncultivated soil, while with the cultivated soil only part is conducted down and the remainder radiated.

There are many other factors at work in Nature tending to reduce soil temperature, but these factors will not admit of being discussed here.

Thus it will be seen that the subject of soil temperature is a most complex problem, and in order to arrive at conclusions which are at all definite it must be investigated from many stand-points, and, as far as possible, under both natural and controlled conditions.

With the object of demonstrating and studying the diurnal variations in soil temperature, and in what relation these variations stand to varying depths of soil, an interesting set of observations, embodying

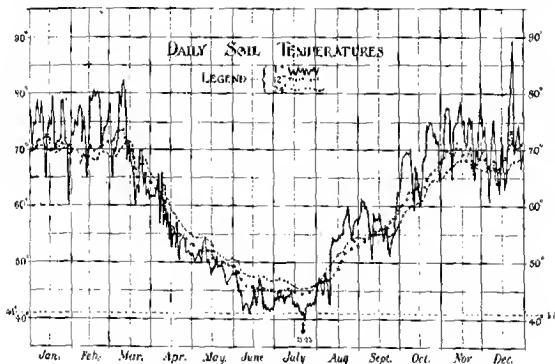


FIG. 1. MEAN OF MAXIMUM & MINIMUM TEMPERATURES

daily readings of maximum and minimum thermometers is being carried out at the Central Research Station, Werribee. In the northern face of a specially-constructed pit a maximum and a minimum thermometer have been placed horizontally at each of four depths in the natural soil, e.g., at depths of 1 inch, 6 inches, 12 inches, and 24 inches, respectively, from the surface of the soil. The construction of the thermometer receptacles and soil pit is such that the effects of any external atmospheric temperature on the readings of the soil thermometers have been reduced to a minimum, so that the temperatures recorded by the thermometers represent the actual soil temperatures at the above depths. The readings are taken at 9 a.m. every day throughout the year, and carefully recorded on a special temperature card.

When the means of the maximum and minimum temperatures for each depth are plotted in the form of graphs, many interesting and important factors are brought to light. By reference to Fig. 1 it will be seen that the 1-inch graph is a series of variations which oscillate from day to day, and clearly illustrates the wide ranges of temperature to which the surface soil is exposed.

It will also be noticed that, as the depth increases, the temperature variations diminish in amplitude. Even at the 24-inch depth the daily variations are practically negligible, the 24-inch graph being represented

by a gradual rise or fall. Another point of interest is that each curve cuts each other curve at least twice during the year; for a certain period the upper layer of soil is giving, and for the remainder of the year is receiving, heat from the layer above or below. In the warm months of the year the 1-inch curve occupies a position above the other curves, but

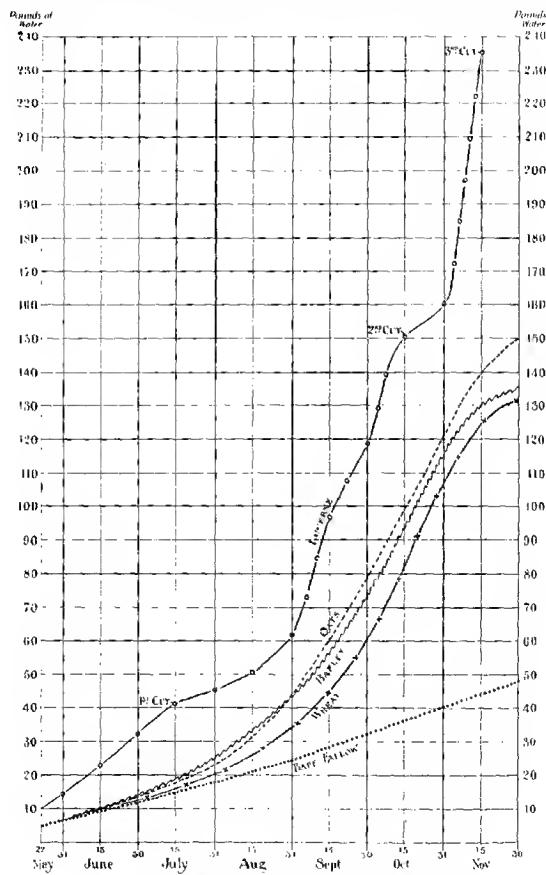


FIG. 2. TRANSPIRATION & EVAPORATION CURVES.

during the cold period of the year the positions are entirely reversed, the layers of soil furthest removed from the surface registering the higher temperatures.

As has already been mentioned, vegetative growth is dormant below 41 deg. F., and by reference to Fig. 1 it will be seen that the temperature

of the 1-inch soil layer fell below the 41 deg. F. only once during the whole year, and then for a very short period, *e.g.*, three days—21st to 23rd July inclusive. From this data it would be safe to infer that vegetative growth as far as the Werribee soil was concerned was never at a standstill at any period of the year, for by the period mentioned—21st to 23rd July—all winter crops were firmly established with their roots in the deeper layers of soil where the temperature was more congenial.

This assumption is confirmed by reference to Fig. 2, which illustrates in graphic form the "Transpiration and evaporation" curves of wheat, oats, barley, and lucerne plants growing in close proximity to the soil temperature pit, and under comparatively identical soil temperature conditions. The curves show no decided break in continuity, which would be indicative of a check in growth at any stage in their growing period. Another point of interest in reference to Fig. 1 is that the increase of temperature from spring to summer is more rapid than the decrease from autumn to winter, as is exemplified by the relative steepness of the curves.

These few soil temperature observations have brought to light many points of interest, and as more data is made available by the pursuance of these records over a number of years, more definite conclusions will become available to extend our scope of a subject which, besides being very complex, has an important bearing on vegetative growth.

RETURN OF LIVE STOCK IN VICTORIA, MARCH, 1915.

Districts.	Horses.	Cattle.			Sheep.	Pigs.
		Dairy Cows (milking and dry).	Other Cattle.	Total.		
Central	118,402	122,310	106,190	228,500	1,280,698	41,175
North-Central	32,992	39,296	48,243	87,539	1,000,461	11,786
Western	87,169	165,494	162,530	328,084	4,020,120	60,870
Wimmera	63,279	19,757	21,361	41,118	1,556,566	7,365
Mallee	42,847	11,502	14,717	26,219	404,135	7,211
Northern	102,074	62,274	63,698	125,972	1,355,410	25,750
North-Eastern	45,715	51,136	119,905	171,041	1,044,310	20,395
Gippsland	59,573	138,748	213,321	354,069	1,380,985	68,635
Total March, 1915	552,053	610,517	752,025	1,362,542	12,051,685	243,196
" 1914	562,331	636,080	872,473	1,528,533	12,113,682	221,277
Increase	..	..	..	..	..	21,919
Decrease	..	10,278	45,563	120,448	166,011	61,997

A. M. LAUGHTON,
Government Statist.

Office of the Government Statist,
Melbourne, 17th May, 1915.

COST OF PRODUCTION OF FIELD CROPS.

I.—WHEAT.

By H. C. Wilson, Manager Central Research Farm, and A. J. Whelan, Field Officer, Werribee.

During the late autumn months of 1914 it was decided by the Department of Agriculture to put under wheat a field of 345 acres acquired on lease from the Closer Settlement Board, and to record exactly the total cost of production.

Operations commenced on 20th June, 1914.

Previous History of the Land.

Before taking over the lease of this land in June, 1914, grazing had been practised for a period of six years, leases being granted from time to time by the Closer Settlement Board to graziers.

By local information gathered it has been ascertained that this land carried six cereal crops during the years 1899-1908, many of which during the later years of this period being taken consecutively.



Ploughing with Stump-jump Plough, Research Farm, Werribee.

The Soil.

The soil is very patchy, varying from stiff red clay loam to light grey loam, with occasional low black beds of soil, badly drained. Of this latter soil there is about 2 acres only. The subsoil is near the surface, and, although the ploughing was only 4 inches deep, the clay subsoil was brought up by the implements in places. This subsoil varies from yellow, tenacious clay to permeable, red clay loam of basaltic formation. Its valuation should be £8 per acre.

Natural Grasses, Herbage, Pest Weeds, &c.

As this paddock has not been cropped for the past six years, the natural native pasture was good and established. The pest weeds were hardly noticeable.

Because of the constant grazing practised, the annuals have become so scarce that they could be noticed only in patches, this condition favouring the perennial native root-grasses, and encouraged their predominance in the pasture.

Preliminary Work.

A start was made on 20th June, 1914. Owing to the distance of this land from the farm buildings (some 3 miles), the erection of rough camping conveniences for men and horses was undertaken before the ploughing, at a cost of £4 11s. 6d. This work included sinking a small water-hole, erection of some 4 chains of fencing, feeding arrangements for horses, and the shifting of a 12-ft. x 15-ft. iron hut for the men from the farm homestead.

Fallowing.

On the 26th of June, 1914, two four-furrow ploughs were started (one disc and one mould-board), with six horses in each, ploughing to a depth of 4 inches. The weather was favorable, and six working days a week were realized, the horses being actually in the ploughs for about 8½ hours a day during the greater part of the ploughing season.

The condition of the soil was very good at the outset of operations, but as the work progressed, rain being scarce in the late winter months, some difficulty was experienced in maintaining the requisite tilth, and owing to the scarcity of these winter rains it was decided to follow the ploughs with a heavy double harrowing, keeping the work well in hand. These fallowing operations were completed on 3rd September.

Summer Working of Fallows.

During the period 24th September to 12th December, 1914, the whole of the area was again double harrowed, and during 28th November, 1914, to 28th January, 1915, a spike rolling and harrow attached behind was undertaken. After the roller came the spring-tooth cultivator tilling to a depth of 3½ inches from 26th December to 27th February, 1915. The condition of the soil after this last working being considered satisfactory, a cessation of the work was allowed until seeding commenced on 17th April.

Seeding Operations.

The whole of the land was harrowed with heavy harrows immediately before and after the drills, and the seeding operations, which were favoured with ideal weather conditions, occupied from 17th April to 3rd May. Two seventeen-hoe disc drills and two sets of six harrows each were used. On the whole, a very excellent germination resulted; 1.72 inches of rain fell the week before the seeding started, and 2 inches the week after completion. These rains were very seasonable. The 1.72 points which fell previous to seeding came steadily, and soaked well into the ground, while the 2 inches which were recorded immediately after seeding was distributed over a period of eight days, thus insuring a very excellent germination. At the date of this report a very even crop is to be seen, consisting of twelve separate varieties of pure seed wheat to be marketed as seed next season. The varieties sown are:—Federation, Yandilla King, Marshall's No. 3, Penny, College Eclipse, Warden, Dart's Imperial, Commonwealth, Currawa, King's Early, Hugenot, and Zealand Blue. These are representative varieties of the best known Australian wheats.

The following tables will show the total cost of cultivation and seeding. Table No. 1 for present year, table No. 2 for years of normal fodder values:—

TABLE NO. 1.
LOSS OF PRODUCTION OF SEED WHEAT WITH MARKET VALUES OF REED AT DATE OF OPERATIONS

Notes on Table No. 1.**POINTS OF INTEREST TO FARMERS.**

In submitting the foregoing table, the exact costs have been recorded during the dates of each operation.

MARKET VALUES OF FODDERS.

It will be noticed that actual values on the farm of all horse feed used have been charged in accordance with the varied fluctuations of the market during the present season. The molasses used is the only exception to this rule. Beet sugar molasses was purchased in bulk two years ago, and as varying market values of this food are hard to determine, we have, therefore, charged molasses at £1 10s. per ton. The prices of chaff ranged from £2 10s. to £9 per ton, and crushed oat seconds from 2s. to 5s. per bushel during the period 26th June, 1914, to 3rd May, 1915.



Summer Cultivation of Fallow.

RATION FED TO HORSES.

A perusal of Table No. 1 will show that the horses consumed—

38 lbs. oaten chaff	/	per day.
7 lb. crushed oat seconds	/	per day.

during ploughing and immediate harrowing operations, from 26th June to 3rd September, 1914. The value on the farm of this oaten chaff and crushed oat seconds was 50s. per ton and 2s. per bushel respectively. This ration worked out at 1s. 2*½*d. per horse per day.

In calculating the cost of each separate cultivation, the horse feed consumed during the days that the horses were idle (Sundays and holidays) has been charged to the operation as well as the feed used during the working days.

Thus it will be seen that in the ploughing season forty-six working days and eight idle days, totalling 54 in all, have been charged for in calculating the cost of ploughing. The same applies in every case that days were lost through wet weather, Sundays, and holidays.

VALUE OF LUCERNE CHAFF IN RATION.

A change of food was given during the rest of the cultivation and seeding operations, and the average ration fed to each horse during the dates 24th September, 1914, to 3rd May, 1915, was—

Oaten and lucerne chaff, mixed in equal proportions, 31 lbs.

Crushed oat seconds, 2½ lbs.

Beet-sugar molasses, 2 lbs.

This, then, is a comparatively cheaper ration than the first ration fed of 38 lbs. oaten chaff and 7 lbs. crushed oat seconds, and apparently the horses did as well in each case. These rations represent the actual food that the horses ate, and they were given as much as they would eat four times a day.

VARYING COSTS OF RATIONS.

A great difference will be noticed in the cost of the ration per horse varying with the market value of the fodder consumed. During 24th September-11th October, 1914, with oaten and lucerne chaff mixed at £3 10s. per ton, crushed oat seconds at 2s. 3d. per bushel, and molasses at 30s. per ton the horses only cost to feed 1s. 1¾d. each per day, while seven months later, with chaff valued at £9 per ton, crushed oats at 5s. per bushel, and molasses at 30s. per ton, the cost of the ration was 2s. 10d. per horse per day.

THE SEPARATE CULTIVATIONS.

Ploughing, four inches deep, at the average rate of 3½ acres per day, was completed this season at a cost of 5s. 3 4-5d. per acre. This average was maintained after calculating in the four working days lost as holidays and wet weather. One four-furrow stump-jump mouldboard plow and one four-furrow disc plow each took part in the fallowing. There seemed to be little difference in the comparative efficiency of those two implements. The cost of maintenance of the plough shares on the mouldboard plough was greater than the wear and tear in the case of the disc plough, but the area covered in the case of the former was slightly in excess of the work done by the latter, owing to the 4 inches extra width covered by the mouldboard plough. The quality of the work and the lightness of draught with these ploughs seemed this season to share equal honours.

Harrowing was done with a team of six horses attached to a set of six heavy harrows at the rate of from 23 to 26½ acres per day, and at a cost ranging from 9d. to 1s. 3 3-5d. per acre—9d. when the horse feed was cheap and 1s. 3-35d. per acre when the price of fodder was dear.

Cultivation was done with a 7-ft. cultivator (Massey Harris spring tooth) to a depth of 3½ inches at 2s. 9d. per acre, with chaff at £7 per ton and crushed oat seconds at 4s. per bushel. The average area covered per day was approximately 8 acres.

DRILLING.

Two 17-hoe disc drills were used and averaged 15 acres per day, at a cost of 1s. 5 2-5d. per acre, with chaff at £9 per ton and oats at 5s. per bushel.

TILTH OF LAND.

After these ten cultural operations the land was left in an excellent condition; the whole were absolutely necessary probably because of the

dry season experienced during fallowing, and the comparative virgin nature of the land.

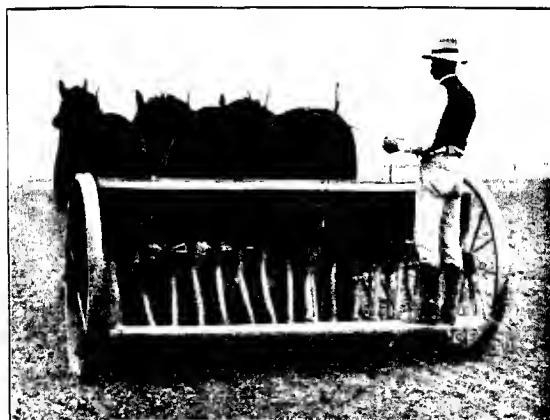
SINKING FUND INTEREST, OIL, AND REPAIRS.

Fifteen per cent. Sinking Fund and interest have been calculated and allowed on the total capital value of the whole of the implements and horses used on each cultivation. The cost of shares, repairs, and oils have also been allowed for.

SEED, MANURE, RENT, AND TEMPORARY IMPROVEMENTS.

The price of seed wheat has been charged at 9s. per bushel, 62 lbs. per acre on the average being shown.

Superphosphate 36-38 per cent. Sol was applied at the rate of 107 lbs. per acre. Value, £4 5s. per ton.



Sowing the Seed with a Disc Drill, Research Farm, Werribee.

The rent on the land is £207, and the temporary improvements erected at the outset of the work, £4 11s. 6d., have been held over from the total cost until the balance-sheet is prepared after the completion of the harvesting of this field.

COSTS.

The cost, then, after allowing for cultivation, seed, and manure, £1 10s. 2½d. per acre, and the total cost of the 345 acres sown this season, is £520 13s. 10½d.

Notes on Table No. 2.

This table has been calculated to show the cost that would be incurred in years of normal fodder and seed values. All other calculations are taken from table No. 1, and based on the facts gathered from the field of 345 acres sown this season.

TABLE NO. 2.
YIELD OF PRODUCTION OF NEED WHEAT, WITH AVERAGE MARKET VALUES FOR FEED ON FARM.

NORMAL FODDER VALUES.

Oaten chaff has been valued at £2 15s. per ton on the farm, exclusive of bags.

Oaten and lucerne chaff mixed has been valued at £3 per ton on the farm, exclusive of bags.

Crushed oat seconds has been valued at 1s. 9d. per bushel on farm, while beet sugar molasses has been valued at £1 10s. per ton on farm throughout the fallowing, cultivation, and seeding operations.

Graded seed wheat sown is valued at 5s. 6d. per bushel, and super-phosphate at £4 5s. per ton.

The cultural operations, with these average prices of food, have been worked out at:—

s. d.
5 4 per acre for <i>Ploughing</i> .
0 8½ per acre for <i>Harrowing</i> .
1 10½ per acre for <i>Cultivation</i> .
0 11 per acre for <i>Drilling</i> .

If, however, a damper fallowing season had been experienced the ten cultural operations which were necessary to ensure good tilth this season would not have all been necessary, but the days lost through wet conditions would probably have been increased during the ploughing season, and thereby add to the separate costs of the cultivations necessary under these altered conditions.

COSTS WITH FODDER AT STANDARD VALUES

With these standard values, then, the cost has worked out at £1 3s. 4½d. per acre, and the total cost of the 345 acres at end of seeding shows an expenditure of £403 3s. 4d., or 6s. 9½d. less per acre than it has cost during the present season with fodder values very high.

BAYONET GRASS, ETC.

While in the Benalla district this week I was much impressed by the value of the plant known by various names in different districts as bayonet grass, sword grass, and spear grass, for fodder purposes.

In its natural state stock will not eat it, but when grubbed out below the bulbs they will thrive upon the lower portions, and both cattle and sheep are being fed in this way in large numbers at present, while, at the same time, the grass is being cleared out.

Some farmers state that their stock thrive better on this fodder than when hand fed on hay, chaff, &c.

There are many thousands of acres on which this plant grows, and there must be hundreds of men who do not know its value, and who should be glad to hear that it can be put to such a useful purpose, and may be the means of saving hundreds of cattle and sheep during the next three months.—[TEMPLE A. J. SMITH, Chief Field Officer, Agricultural Department.]

ECONOMICAL FEEDING OF STOCK.

FACTS IN FEEDING HORSES.

By J. W. Paterson, B.Sc., Ph. D. (Professor of Agriculture, University of Western Australia).

A horse requires food if it is not working; this food may be considered as maintenance. If it is working it requires food in excess of this, and the excess may be considered as fuel. If a steam-engine is to do a certain amount of work it requires a certain amount of fuel, and the same is true of a horse. A steam-engine can use only about 7 per cent. of the energy contained in the fuel, whilst a horse can use 31 per cent. The fuel of the engine is wood or coal, and the fuel of the horse is the digested, assimilated food. Various things have to be looked to in a food, viz.:—

- (1) Composition.
- (2) Digestibility.
- (3) Energy spent in digesting it.

COMPOSITION.

Green foods contain about 75 per cent. of water, and this leaves less room for the nutritive materials or dry matter in a ton of food. If well made, the dry matter in hay is as good as in the green material, and there is from three to four times more in a ton of it. The useful materials in the dry matter are the proteins, fats, and carbo-hydrates, all of which are available as animal fuels. The cereal grains supply much carbo-hydrates (starch, &c.), as also do beans and peas, but the latter are much richer in proteins. Oats and maize contain 5 or 6 per cent. of fats, while wheat and barley contain very little. As food to a horse, proteins are $1\frac{1}{4}$ times better fuel than starch, and fats are nearly $2\frac{1}{2}$ times better. Foods always contain fibre, and whilst herbivorous animals, like the horse, require some fibre, an excess diminishes the value of the food. The proteins, fats, and carbo-hydrates of foods are each of them groups of substances, and chemical analysis should be used only to compare foods of the same class. It is wrong to compare, say, lucerne hay with maize on the basis of its analysis, because in lucerne the fats and carbo-hydrate groups are differently made up and show a wide difference in their digestibility.

DIGESTIBILITY.

Concentrated foods like grain and cakes are more thoroughly digested than coarse fodders like bran, hay, or straw. From careful experiments it has been found that a certain percentage only of each constituent of each food is digested, and what is not digested is of no use. Of wheat and maize almost 90 per cent. is digested; of linseed cake, 80 per cent.; oats, 70 per cent.; bran and lucerne, 60 per cent.; and wheat straw, about 40 per cent. The digestibility of hay is seriously injured by ripening before cutting, in some cases being reduced from 65 per cent. to 48 per cent. According to recent investigations at the Roseworthy (S.A.) College by Professor Perkins, the best time to cut wheaten hay is three weeks after full bloom, when the grain is about to leave the milky stage and become doughy, but some farmers think this is too late. Knowing the composition of any food, and the digestibility of its

various constituents, the percentage of digestible proteins, fats, and carbo-hydrates which it contains can be easily calculated.

ENERGY EXPENDED IN DIGESTION.

Until quite recently it was believed that when one had found the percentage of digestible constituents in a food, the information as to its value was complete. This is wrong, and another very important item must be considered. A deduction must always be made from the value of the food digested on account of the energy which is spent in effecting the digestion. The amount to be so deducted depends upon the class of foods. It is greatest with the fibrous or coarse fodders. Thus, with maize or wheat, about 10 per cent. of the energy of the food digested is spent in digesting it; with linseed cake, 18 per cent.; oats, 20 per cent.; bran, 23 per cent.; lucerne hay, 48 per cent.; and poor wheat straw, 168 per cent. An animal restricted to straw of that class would obviously die. The energy spent on digestion, being spent inside the animal, will help to maintain its temperature, but it cannot be used again to pull a plough or a dray. The value of a horse feed, therefore, depends upon the amount of digested fuel, but minus the fuel spent in digesting the digested fuel. This is the net amount available for doing work. Considered in this way, 100 lbs. of maize, 106 lbs. of wheat, 113 lbs. of linseed cake, 144 lbs. of oats, 166 lbs. of bran, 288 lbs. of lucerne hay, have each of them the same value in enabling a horse to perform work.

The food required to keep an idle horse living is often termed its maintenance diet. Fibrous foods are all right for a maintenance diet, as the energy spent in digesting them helps to keep up the body temperature. About 10 lbs. daily of good lucerne hay and 5 lbs. of straw can keep a horse of 1,100 lbs. at constant weight under favorable conditions. If put to work, however, the ration must be immediately improved by an addition of cheaply digested foods which offer a big surplus of energy after their own digestion is accomplished. Straw, lucerne, and bran are thus cheap maintenance foods, but are not cheap foods for topping up the maintenance diet when a horse is required to do work.

AMOUNT OF FOOD.

Work is measured by foot-pounds. At ordinary work a horse does about ten million foot-pounds per day, and at hard work fifteen million foot-pounds. One pound of digested assimilated starch, or its equivalent, supplies energy for nearly one and three-quarter million foot-pounds, and thus for ordinary work about 6 lbs. of digested assimilated starch or its equivalent, and for hard work 9½ lbs. are required. The latter could be supplied by 17 lbs. of oats, or 13 lbs. of an equal mixture of oats and maize, or 19 lbs. of an equal mixture of oats and bran. These foods will be in addition to the hay and large foods required for maintenance.

ALBUMINOID RATION.

The chief thing to attend to in a labour ration is to supply sufficient digested food in the form of starch or its equivalent. It is now known that work does not require a ration rich in protein (albuminoids). "Albuminoid ratio" means the ratio of the digested proteins to the digested non-proteins in the food reckoned as starch. A ratio of 1 : 7

would be ample for draught horses, and a diet of oats and good hay is easily within the limit. A ration containing all its grain, as maize, would be risky, if the hay were poor, and the addition of molasses would make it worse. With these exceptions it is unnecessary to trouble about an "albuminoid ratio." Fast horses require a rather higher proportion of albuminooids (proteins) than draughts, and for these maize should only be used in small quantities.

MIXING FOOD.

The proteins of each kind of plants are built up of certain simpler bodies called amino-acids, just as a house is built up of bricks. It is always safer, and usually more economical, in feeding farm stock to use a mixture of foods derived from different plants. By doing so, a lack, or deficiency, of some of these simpler bodies in the proteins of one plant may be made up by a surplus in the proteins of another. On this account bran or wheat go better with oaten than with wheaten hay, and maize goes well with either. Taken by themselves, oats make the best corn for horses, but not the most economical. The following

DAILY RATIONS

are suggested in the latest issue of the *Journal of the Board of Agriculture* (England), and may be reproduced:—(a) Draught horses: Ration 1, 18 lbs. of hay, 14 lbs. of oats, cost 1s. 8d.; ration 2, 18 lbs. of hay, 6 lbs. dried grains, 2 lbs. pollard, 4 lbs. bran, 2 lbs. maize, cost 1s. 2d. (b) Light-legged horses: Ration 1, 10 lbs. hay, 16 lbs. oats, cost 1s. 7d.; ration 2, 10 lbs. hay, 6 lbs. oats, 2 lbs. beans, 5 lbs. dried grains, 2 lbs. bran, cost 1s. 3d. Smaller horses require less. The hay referred to in these tables is presumably grass or clover hay, but the difference between that and good cereal hay need hardly be considered for local practice. In considering the value of a food, suitable composition, digestibility, and cost of digesting are not everything. Palatability, regular feeding, and general good management are essential to success.

FERTILIZERS IN JAPAN.

The amount of artificial fertilizers imported into Japan during 1913 was 10 per cent. of the total imports.

Over 7½ million pounds worth of various artificial fertilizers were imported. According to a British consular report a certain amount of the manure was used for mulberry trees, but most of it is used for food crops, especially rice.

The item of greatest interest is sulphate of ammonia, 110,635 tons, valued at £1,643,600—approximately 25 per cent. increase from the preceding year. Nearly the whole of this came from the United Kingdom, while a small amount, valued at £25,000, came from Australia.

To producers of sulphate of ammonia it will be of interest to note that a Mond gas plant is being installed at the Fustun coal mines in Manchuria. This plant has been specially designed for the recovery of sulphate of ammonia, as it has been discovered that Fustun coal is particularly suitable for this purpose, and it is estimated that 250 tons of coal will be gasified per day, giving a daily yield of 12 tons of ammonium sulphate.—[Extract from *Fertilizers*, 3rd October, 1914.]

RESULTS OF LUCERNE TESTS—SEASON 1914-15.

CENTRAL RESEARCH FARM, WERRIBEE.

By A. E. V. Richardson, M.A., B.Sc., Agricultural Superintendent.

THE DRY SEASON.

The past season has severely tried all those engaged in agricultural pursuits in Southern Australia. The agriculturist has not only had to suffer the partial, or complete failure of his wheat and hay crops through drought, but his resources have been taxed to the utmost to keep his sheep and cattle alive, and his horses in working condition.

Hay and straw stacks, accumulated during years of plenty, have, owing to failure of grass, literally melted away before the requirements of live stock, and prices of these commodities have soared to famine levels. As a consequence, foods which, in normal years are rarely fed to stock, *e.g.*, onions, sugar-beet, and potatoes, have been used to supplement the scanty supplies of hay and straw.

The drought has been weathered, and the losses of stock in the State, as revealed by the figures issued by the Government Statist, are not as heavy as one might perhaps have expected. Nevertheless, the losses are sufficient to impress on the community the need for protection against future dry spells, and the imperative necessity for increasing water storage and irrigation settlements of the State.

With the extension of irrigation, greater attention will be paid to the production and conservation of fodder crops, and loss of stock which is the worst feature of periodic droughts will, to a very large extent, be mitigated.

Of all the forage crops that can be grown under irrigation it is questionable whether any can approach, much less surpass, irrigated lucerne, in general utility.

Advantages of Lucerne.

In growing forages on an irrigation farm the farmer must necessarily be guided in his choice by the cost of production, and the yield per acre. From irrigated lucerne he may confidently expect five cuttings in a season, and the effective life of the plant varies from seven to fifteen years, according to the manner in which it is treated. Consequently the annual expense of preparing the seed bed, purchasing and sowing the seed, is eliminated (an important feature on an irrigated holding), and this makes the cost of production relatively low. But, low though its annual cost is, it is nevertheless a most prolific yielder, as we hope to show in the sequel.

Two further advantages accrue from the cultivation of lucerne:—

- (1) It possesses a high percentage of protein—the most valuable and expensive ingredient in foodstuffs, and this enables the farmer to provide a balanced ration on the farm, without having to purchase nitrogenous concentrates like bran. The hay is appreciated by all kinds of live stock, and those, who, by force of circumstances, have this year used it for the first time, have probably been surprised at the feeding value of well-cured lucerne hay.

- (2) Finally, lucerne is the greatest soil renovator known to agriculture. Its immense root system exerts a remarkable subsoiling effect on the lower layers, brings up mineral plant food from great depths, and also accumulates nitrogen from the air, and fixes it and increases the soil fertility.

Optimum Conditions for Lucerne.

Lucerne is certainly a prolific yielder of forage, but it gives best yields only when the soil and climatic conditions are thoroughly satisfactory. Every cultivated plant must, of course, have certain optimum soil conditions to give maximum growth. These soil conditions vary with the nature of the plant. Rice requires an abundance of water in the soil, verging on saturation. Wheat, on the other hand, does best with a soil at 40-45 per cent. of its water-holding capacity. What are the most favorable soil conditions for obtaining heavy cuts of lucerne? They may be divided under three heads:—

- (1) Water requirements.
- (2) Plant-food requirements.
- (3) Cultivation requirements.

These have been the subject of experimental investigations at the Central Research Farm, Werribee. Let us consider the results seriatim:—

(1) WATER REQUIREMENTS OF THE LUCERNE CROPS.

Lucerne, in common with all other forage plants, requires large quantities of water to make full growth and development. Water acts as a vehicle, conveying in solution, from root to stem and leaf, the mineral matter necessary for building up new tissues. For every pound of new tissue elaborated a certain definite quantity of water must pass through the plant, and evaporate from the leaves. Let us see how much water must be transpired in order to build up, say, 1 ton of dry lucerne hay. The importance and value of such information is obvious: for if we can determine how much water is required to produce a ton of lucerne hay, we may estimate the maximum amount of forage that can be grown under a given rainfall; the amount of irrigation water that must supplement the rainfall to produce a definite quantity of forage, as well as the most effective applications of irrigation water at the varying seasons of the year.

How to Measure the Water Requirements of Lucerne.

So far as is known, the exact measurement of the water requirements of our various farm crops has not hitherto been attempted in Australia. A short description of the methods adopted for estimating the water requirements of typical farm crops may therefore be of interest.

The amount of water required for lucerne can be determined with considerable accuracy. Consider a crop growing under ordinary field conditions. The water that falls on the soil as rain may disappear from the soil in three ways:—

- (a) Pass by percolation into the subsoil beyond the reach of the roots.
- (b) Evaporate from the surface of the soil.
- (c) Pass into the roots of the growing crop, and out as water vapour through the leaves.

If the measurement of water requirements is conducted under ordinary field conditions it is impossible to eliminate the first source of loss, except by growing the crops in specially-constructed drain gauges. If, however, the crop is grown in large pots, the loss by percolation is absolutely cut off, and only two sources of loss of soil water remain, namely—

- (a) Evaporation from the soil.
- (b) Transpiration through the crop.

Further, if a control-pot is taken, in which no crop is grown, there obviously is only one source of loss. An accurate method of studying the actual quantity of water required by lucerne is to have a series of pots of uniform size and weight, filled with soil under uniform conditions, and sow lucerne in one half the pots, and allow the other half to lie under bare fallow. The pots growing the lucerne lose water—

- (a) By transpiration through the crop.
- (b) By evaporation from the soil surface.

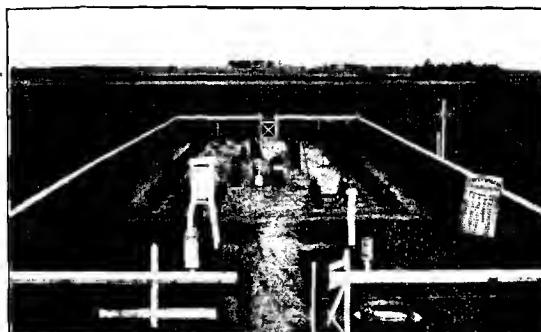


Fig. 1.—General view of Pot Enclosure, Werribee, used for the determination of the water requirements of plants. The pots are kept at ground level in order to prevent fluctuations in temperature. In the foreground is meteorological apparatus for recording (a) air and soil temperatures; (b) hours of bright sunshine; (c) humidity; (d) rate of evaporation.

The pots under bare fallow lose water by evaporation only. The difference between the weights of the two series of pots at any given time will give the amount of water transpired by the lucerne.

The pots in which the experiment was conducted were 16.32 inches in diameter, and 27 inches deep, and contained 280 lbs. of moist soil. In order to reduce the evaporation to a minimum the soil was covered with 2 inches of gravel. The pots were kept at the same temperature as the soil, in the open, and, as far as possible, under actual field conditions. The amount of water falling on the pots was determined by two rain gauges, and by two specially-constructed water measurers (fig. 1), exactly the same diameter as the pots. The amount of water which fell on the water-collectors was measured in cubic centimetres, and the amount checked against the quantity in the rain gauges.

To determine the water requirements of lucerne four pots were used, two of which were kept as controls under bare fallow, and two were

sown with Hunter River lucerne. The pots were weighed weekly throughout the year (fig. 4) on a specially-constructed steelyard, capable of measuring a load of 300 lbs., and turning to less than 1/10th of a pound.

As each crop of lucerne matured it was carefully harvested, and the dry matter in each cut determined in the laboratory.

In spring and summer the lucerne required to be watered in order to maintain full growth, such watering was effected through specially-constructed tubes running to the bottom of the pots.

The whole series of pots was brought to constant weight once weekly by the addition of water lost during the preceding week. As the moisture concentration in all pots was thus maintained fairly constant the rate of evaporation from the soil was uniform in all the pots. The gravel mulch was kept well stirred to reduce water losses to a minimum.

Expressing the Results.

The most satisfactory method of expressing the water requirement is to refer to the amount of water required to produce a definite quantity, say, 1 ton, of dry matter of the particular crop. This quantity is called the *Transpiration Ratio*, and for any given crop is fairly constant.

We will consider, first, the total monthly losses of water from the crop and soil combined, and from the crop alone, throughout the year, secondly, amount of water required to produce a fixed tonnage of lucerne, expressed in inches of rain, and, finally, endeavour to trace a relationship between the transpiration of the crop, and the evaporation from a free water surface. Table I. gives the total monthly losses of water from pots 1 and 8, under bare fallow, representing evaporation from soil only; and pots 3 and 7 under lucerne, and representing combined losses by evaporation and transpiration.

TABLE I.—*Showing monthly losses by Evaporation from pots under Bare Fallow, and by Evaporation and Transpiration, combined from pots under Lucerne; also the losses by Transpiration only (in pounds of water).*

(Size of pots 16·32" in diameter = $\frac{1}{30000}$ acre.)

No. of Pot.	Treatment.	May, June, July, Aug., Sep., Oct., Nov., Dec., Jan., Feb., Mar., Apr.												May, June, July, Aug., Sept., Oct., Nov., Dec., Jan., Feb., Mar., Apr.	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	Bare fallow	4.1	7.2	4.8	5.3	6.8	5.9	10.1	9.8	9.5	5.2	5.0	5.1	7.0	7.9
8	Bare fallow (duplicate)	4.4	7.0	6.0	6.0	8.0	5.9	10.7	12.0	9.9	5.5	5.0	5.6	7.0	8.0
3	Lucerne—														
	(1) Loss by evapo- ration and trans- piration	5.3	23.2	12.2	25.3	46.5	53.3	75.5	54.7	56.2	52.5	19.8	31.5	5.6	48.9
	(2) Loss by trans- piration	4.1	10.2	6.8	19.2	39.1	48.6	64.0	43.8	46.5	47.2	41.8	30.2	4.7	41.6
7	Lucerne (duplicate)														
	(1) Loss by evapo- ration and trans- piration com- bined	7.9	21.8	13.5	25.1	49.6	60.1	82.2	61.0	58.8	57.1	62.7	39.3	6.4	54.6
	(2) Loss by trans- piration	3.7	14.8	8.1	20.0	42.2	54.6	71.5	50.1	49.1	51.8	57.7	34.0	5.3	46.3

This table will be more intelligible if the figures, representing the losses, are converted into the equivalent of inches of rain per acre.

**G GRAPHICALLY
WEEKLY LOSSES
1914-15**

THE CROP DURING SECOND YEAR OF GROWTH.

BARE FALLOW.

FREE WATER SURFACE (EVAPOROMETER)
DEPARATION FROM A LUCERNE CROP
GROWTH.

inches of water per acre
wts. per acre

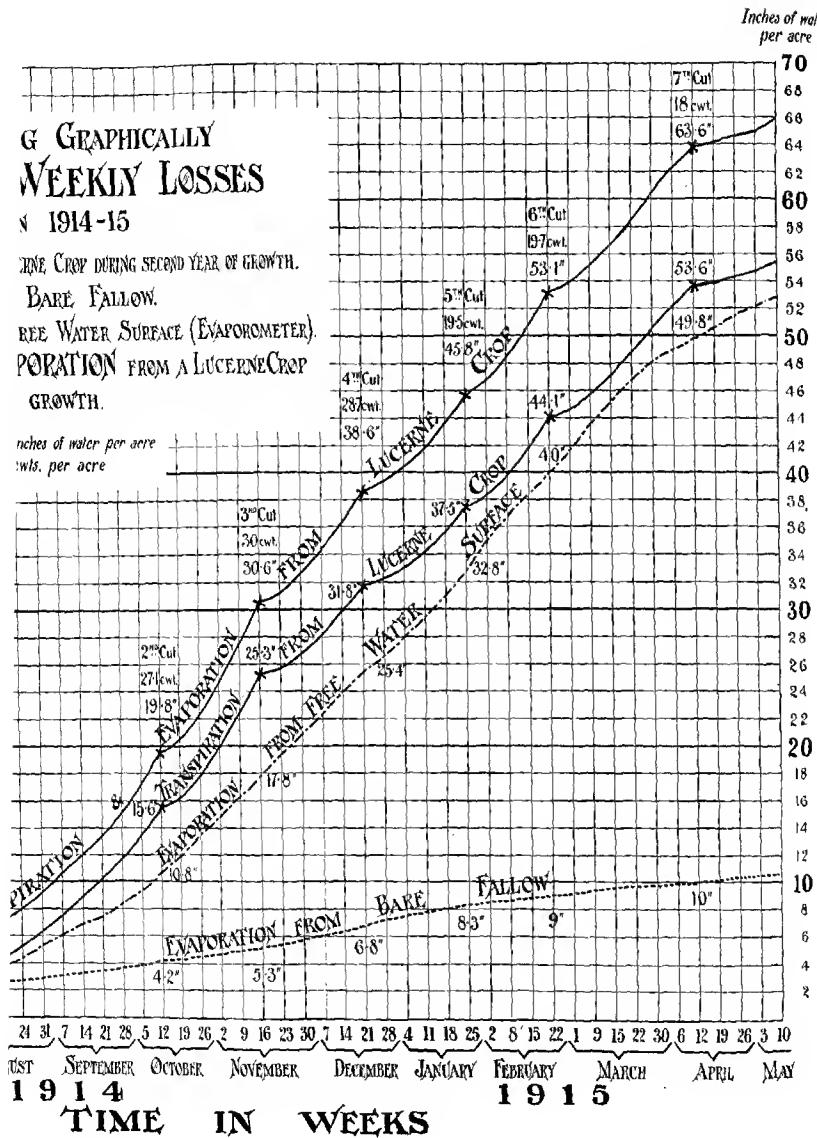


TABLE II.—Showing the monthly losses from a Bare Fallow and Lucerne crop, expressed in the form of Inches of Rain. The monthly evaporation from a free water surface is included for purposes of comparison. (Figures represent inches of rain per acre.)

Pd.	Treatment.	May 10-31 1914, 1914												May 10-31 1915		
		June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	10 days	Total for Year		
1	Bare fallow	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	10	10
	Bare fallow	.55	.96	.61	.71	.91	.79	1.39	1.31	1.27	.99	.66	.65	.10	10	10
3	Lucerne—															
	(1) Loss by transpiration and evaporation	1.10	3.10	1.75	3.33	6.20	7.16	10.97	7.30	7.50	7.00	6.64	4.73	.75	66	66
	(2) Loss by transpiration	.55	2.15	1.63	2.56	5.21	6.40	8.53	5.84	6.20	6.30	5.97	4.02	.60	55.9	
7	Lucerne—															
	(1) Loss by transpiration and evaporation	1.05	2.60	1.80	3.48	6.61	8.05	10.93	8.13	7.84	7.61	8.50	6.24	.85	72	72
	(2) Loss by transpiration	.49	1.98	1.98	2.60	5.63	7.28	9.53	6.88	6.65	6.81	7.60	4.83	.75	61	70
	Evaporation from a free water surface	.73	1.20	.82	2.70	2.90	5.21	6.00	5.50	5.50	6.00	6.50	4.00	1.01	52	30

The results may even be more clearly expressed by reducing them to graphical form, and plotting the period of growth horizontally, and the water requirements vertically.

In order to bring out the differences, as well as the relationships of these figures, the cumulative weekly losses from Lucerne, Barefallow and Evaporation from a free-water surface throughout the whole year are given in graphical form in the foregoing chart.

CHART.—Shows the Cumulative Weekly Losses (expressed in inches of rain per acre) throughout the entire season from plots treated as Bare Fallow, and with Growing Lucerne; also losses by Evaporation from a Free-water Surface for the same period.

This chart summarizes, in a graphical manner, the seasonal water requirements for a crop of lucerne in its second year of growth.

It will be noted that, after each cut, the curve of transpiration flattens, representing diminished water requirements of the young lucerne. As the lucerne develops, the curve of transpiration becomes steeper and steeper, reaching a maximum immediately before cutting.

The curve representing the evaporation from a free-water surface is plotted to the same scale, and it will be noted that the crop throughout the year transpired more water than is lost by evaporation from a free-water surface. That is to say, an acre of lucerne in full growth will evaporate more water through its leaves than the amount that would be evaporated in a year from an acre of standing water, with the hot winds and sun constantly playing on it.

From the graph it will be seen that the seven cuts required no less than 54 inches of water per acre to pass through the crop.

During the same period the soil, though well mulched, lost 10 inches of water by evaporation, consequently the total loss from the crop and the soil was 64 inches.

Throughout the whole year the amount of dry matter produced by the Lucerne was 8 tons per acre, consequently the crop required 8 inches

of water to produce 1 ton of dry matter, and of this approximately $6\frac{1}{2}$ inches passed through the lucerne crop, and $1\frac{1}{4}$ inches was dissipated from the soil by evaporation.

The following table gives further details as to the weight of dry matter, and quantities of water used:—

TABLE III.—*Showing Number of Cuttings, Weight of Dry Matter, and Amount of Water required for production of 1 ton dry matter for Lucerne Crop, during second season of growth, Werribee, 1914-15.*

No. of Pot.	Date of Cutting	Weight of Dry Matter in Grams.	Calculated Weight per Acre.	Water used in Inches per Acre for Seven Cuts.	Transpiration Ratio—Tons of water required for Production of 1 Ton Dry Matter.
		Grams per Pot.	Cwt. per Acre.	Acre Inches.	Tons.
Pot 3 ..	1st, 13th July, 1914 ..	29·2	17·1	54·0	675
	2nd, 12th Oct., 1914 ..	47·02	27·1		
	3rd, 16th Nov., 1914 ..	50·25	30·0		
	4th, 21st Dec., 1914 ..	48·0	28·7		
	5th, 25th Jan., 1915 ..	32·97	19·5		
	6th, 22nd Feb., 1915 ..	33·4	19·7		
	7th, 15th April, 1915 ..	30·25	18·0		
		271·09	160·1		
Pot 7 .. (Duplicate)	1st, 13th July, 1914 ..	31·2	18·5	60·9	687
	2nd, 12th Oct., 1914 ..	53·2	31·2		
	3rd, 16th Nov., 1914 ..	53·25	31·5		
	4th, 21st Dec., 1914 ..	54·2	32·4		
	5th, 25th Jan., 1915 ..	31·2	18·5		
	6th, 22nd Feb., 1915 ..	35·4	21·1		
	7th, 15th April, 1915 ..	30·0	23·3		
		297·45	176·5		

When expressed in this manner it would appear that lucerne requires more water than any of our farm crops to elaborate a unit quantity of dry matter.

Thus to produce 1 ton of dry lucerne hay approximately 700 tons of water must actually pass through the body of the plant.

The Limiting Factor in Victorian Lucerne Culture.

Now an inch of rain over 1 acre would weigh, approximately, 101 tons; therefore, to produce 1 ton of lucerne, about seven inches of water must actually pass through the growing crop. We see here very clearly a most important limiting factor in the production of heavy lucerne crops in Victoria. Under a rainfall of, say, 21 inches, we may calculate the maximum possible production of lucerne. If the whole of this rainfall could be made to pass through the crop, and none dissipated from the soil by evaporation, then 3 tons of lucerne hay per annum could be raised on a 21-inch rainfall. These conditions, however, could obviously never be realized in practice, for, under the most efficient system of cultivation, considerable losses of water from the soil, by evaporation, are inevitable.

This, indeed, would be specially true after cutting the crop, for then a large proportion of the soil would be exposed to the direct rays of the sun, until the new crop had grown sufficiently to cover the ground.

In ordinary practice, at least, 25 to 33 per cent. of the rainfall would, on an average, be dissipated by direct evaporation, and with poor lucerne stands, and badly cultivated soils, the losses would be still higher.

In the experiments at Werribee 16 per cent. of the water added was lost, in spite of the fact that the surface was protected by a well-stirred gravel mulch.

Assuming, however, that 33 per cent. of the rainfall is a fair estimate of the direct loss from the soil by evaporation, then 2 tons per acre would represent the maximum production possible for a rainfall of 21 inches, provided always, of course, that the lucerne cannot draw on

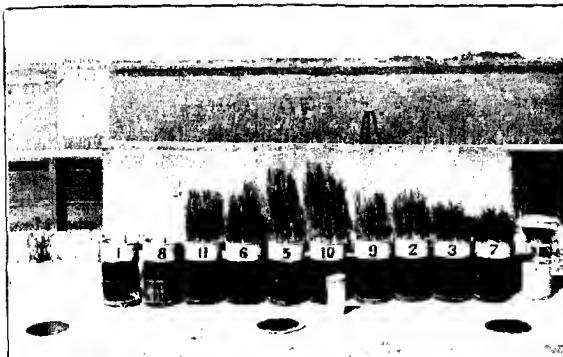


Fig. 2.—Pot experiments to determine the water requirements of farm crops. Each pot holds 250 lbs. of soil. Pots 1 and 8, Bare Fallow; 6 and 11, Algerian oats; 2 and 9, Federation wheat; 5 and 10, Cape barley; 3 and 7, Lucerne. On the right is the water collector, and in the foreground a rain gauge. The pots are placed in the soil in order to keep the temperature of the pot the same as that of the surrounding soil.

subterranean sources of permanent water. Such supplementary sources of water supply are met with in many parts of the State, especially on the banks, and in the neighbourhood of creeks and rivers. One of the most productive lucerne belts in New South Wales, e.g., Tamworth, owes its value of the presence of subterranean supplies of fresh water within reasonable depth of the lucerne roots.

In the Nenningha Valley (New South Wales) the Peel and the Cockburn rivers junction on a fertile plain lying between two high ranges of hills. The eroding action of the stream has, in places, undermined lucerne fields planted two generations ago. Occasionally a portion of the field thus undermined collapses, and the lucerne tap-roots, hanging perpendicularly, like giant whip-cords 25 to 30 feet long, can be seen running straight from soil to underground stream, whence is drawn the greater part of the vitalizing fluid for the support of the

luxuriant crop above. But, in these cases, the amount of rainfall is obviously not the limiting factor in crop production, for the crops are naturally sub-irrigated with permanent and unlimited supplies of water. We may, however, disregard these specially-favoured localities in our discussion.

In the northern irrigated belt of Victoria, where lucerne will be largely grown, as the irrigated area expands, adventitious sources of water, such as described above, will not be available; hence, such lucerne as is sown, must rely on the rainfall, supplemented with supplies of irrigation water.

How much irrigation water must be applied to give satisfactory crops? According to the results obtained at Werribee, 7 acre-inches of water must be transpired by an acre of lucerne to produce a ton of dry matter: this, however, does not include what is lost by evaporation from the soil. Assuming that only one-third of what was applied is so lost, then, at least $10\frac{1}{3}$ acre-inches of water would be required in all for the production of 1 ton of lucerne, and of this 7 inches would be



Fig 3.—A closer view of pot tests showing construction of pots and growth of barley and lucerne in early spring.

required by the crop, and $3\frac{1}{2}$ inches would be lost by evaporation. To produce a crop of 5 tons to the acre, therefore, at least $52\frac{1}{2}$ inches would be needed, and if the rainfall of the district were 21 inches, then $31\frac{1}{2}$ inches, or over $2\frac{1}{2}$ acre-feet, would be needed for the production of 5 tons of lucerne.

Comparison with Field Tests.

The Water Requirements of the 15-acre Bulk Lucerne crop show a close agreement with the results obtained in the Pot Tests. The field was sown in October, 1912, and the quantity of water applied from the time of sowing till the end of the present season (10th May, 1915) was approximately 5.93 acre-feet, or 71.2 acre-inches. During the same period the rainfall amounted to 38.1 inches. The total quantity of rain and irrigation water received by the crop was therefore 109.3 inches in $2\frac{1}{2}$ years under review.

On 10th May, 1915, the lucerne, owing to the drought and failure of the irrigation supply, had practically used up all the available soil

moisture, for growth was at a standstill, though the soil was still warm.

In the $2\frac{1}{2}$ years, thirteen cuts of lucerne were obtained, and these cuts accounted for the whole of the rainfall, the irrigation water, and had also drained the surface soil layers of all free water. Unfortunately the weighbridge had not been installed until the beginning of the second season, consequently the exact quantity of hay obtained the summer after sowing is not known. It is estimated, however, that the three cuts gave a total of 1.5 tons over the 15 acres. The second season's yield (six cuts) weighed over the bridge 6.5 tons per acre, whilst the last



Fig. 4.—Determining the water requirements of farm crops. Method of weighing the pots.

season (four cuts) gave 4.3 tons per acre, a total of 12.3 tons of commercial hay or 10.45 tons of dry matter per acre. As this tonnage required 109.3 inches of water, it follows that to produce a ton of dry matter approximately 10.4 inches of water was used up, representing transpiration through the crop and evaporation from the soil. As 6.9 inches of this passed through the crop, it follows that 3.5 inches must have been dissipated from the soil by evaporation.

Factors Affecting the Quantity of Water Required by Crops.

In describing the results of these tests on the water requirements of the lucerne plant, an endeavour has been made to present the results as

simply as possible, without giving too much detail. There are, of course, several factors which govern the quantity of water required to produce a fixed quantity of dry matter of any particular farm crop. For example, there is reason to believe that if certain fertilizing substances, particularly soluble phosphates, are present in the soil in adequate amounts, the plant can, and does, economize in its water consumption. This might possibly have been expected if we regard water as functioning merely as a vehicle for conveying plant food from the soil to the crop.

With a weak soil solution the plant would require to use more water in order to secure the necessary quota of mineral salts to elaborate a fixed amount of dry matter. Consequently, the addition of soluble fertilizers would in such a case enable a lucerne plant to economize water.

For the same reason a soil kept at a high moisture content by frequent heavy irrigation will cause a lucerne crop to use water wastefully, i.e., transpire a large quantity of water to produce a fixed quantity of hay.

Finally, certain varieties of the same crop differ very widely in their water requirements. This is, of course, notably the case with wheat. Certain varieties of wheat, as our wheat-farmers now know by experience, are more drought-resistant than others.

Just what the cause of this drought-resistance is, is not exactly known. It may be that the so-called drought-resistant wheats transpire less water to produce a bushel of wheat than the others, and are so able to make best use of the scanty rain. It may well be so with the so-called drought-resisting lucernes.

Fig. 5. Determination of the water requirements of summer forages. First cutting of Japanese Millet, January, 1915.

At a later stage we shall have occasion to further consider these problems, and give the results of tests made to determine the effects of fertilizers, moisture concentration, and humidity, on the water requirements of our various farm crops, native grasses, and weeds, and incidentally to inquire into the problem of drought resistance.

Difficulty in Supplying Lucerne with Sufficient Water.

For the present it is sufficient to realize that to produce heavy crops of lucerne under Victorian conditions requires that considerable quantities of water must pass through the growing crop. It is not sufficient merely to pour this water on the soil at more or less regular intervals. Provision must be made to insure that the water is really used by the



plant, and not merely dissipated by evaporation from the soil surface. Unfortunately, in the majority of our northern irrigation settlements where lucerne is the staple crop, the soil tends to set hard, thus preventing a goodly portion of the water applied from sinking well down into the subsoil. These soils, for the most part, contain a large proportion of fine silty particles, and rest on a stiff clay subsoil. They are very retentive of water, and produce excellent crops of wheat and fruit, but they run together on the application of irrigation water, and admit large volumes of water with difficulty. Moreover, their fineness of constitution give them considerable capillary power, and with the extreme evaporation characteristic of our hot, dry summers, the losses of water from the soil, compared with the water that actually passes through the crop, is considerable.

It seems probable, therefore, that a considerable proportion of the irrigation water applied to lucerne crops on such soils is actually lost by evaporation, and fails to serve its primary purpose in providing for transpiration of the crop.



Fig. 6.—Application of water to graded land. Observe the evenness of distribution and the function of the numerous cross checks in damming back the water, thus giving each bay a regular and uniform supply. Good grading insures even watering, and allows the water to sink well down to the subsoil. Good grading and uniform watering are essentials to success in irrigated lucerne culture.

The problem in these settlements would, therefore, seem, not so much a question of fertilizers, as of getting the soil into such a physical condition as will enable it to imbibe quantities of water sufficient to provide for the requirements of heavy crops.

Liming, the application of organic matter, and frequent surface cultivation, will assist, but probably deep stirring or subsoiling will be found extremely beneficial.

The favorable returns obtained at the Central Research Farm may be largely attributed to the deep subsoiling (15-18 inches deep) which the whole of the lucerne area received.

It is matter for regret that portion of the area was not left merely ploughed, and not subsoiled, for purposes of comparison.

At the time the 50 acres were laid down, two and a half years ago, we considered that for profitable lucerne growing on such soil, deep subsoiling was an essential to success, and every acre was accordingly subsoiled.

Thorough grading is another important factor bearing on the question of water supply to the crop.

(2) FERTILIZER AND CULTURAL REQUIREMENTS.

In the February number of the *Journal* a description of the various lucerne experiments was given, and the results of the crop yields for the first three cuts of the season. The manner of preparing the land, the importance of subsoiling and grading operations, methods of seeding and inoculation were discussed in some detail, and further reference to these operations is therefore unnecessary.

(1) Bulk Lucerne Field.

Early in the present season the whole of the plots on the field promised to give exceptionally heavy returns, but, owing to the failure of the Pyke's Creek scheme, no irrigation water was supplied from 24th September to 29th December, 1914—a period of over three months. The first cut was very heavy, being considerably over 50 per cent. heavier than the corresponding cut in the previous year, but owing to the failure of the water supply, due to the droughty season, the second and third cuts, which were grown without irrigation, showed, as might have been expected, a considerable falling off.

Water was supplied to the lucerne on 29th December to 7th January, but since that date no irrigation water was available.

The total area of the lucerne plots is 50 acres, comprising—

- (1) Bulk plots.
- (2) Variety trials.
- (3) Fertilizer and manurial trials, and
- (4) Inoculation and liming tests.

A variable portion of the best of the bulk plots was used for supplying a daily ration of green lucerne to a herd of 40 Red Poll milking cows. This area is not included in the results of the tests.

The details of the weight of commercial hay (calculated at 85 per cent. of dry matter) are summarized in the tables.

TABLE IV.—BULK PLOTS OF LUCERNE.

Season 1914-15 (Four Cuts).

No. of Cutting.	Date of Cutting.		Acreage Cut.	Total yield of Hay.	Yield of Commercial Hay (containing 85% dry matter) per Acre.					
					T.	c.	q.	lbs.	T.	c.
First ... Oct. 16, 1914 ...	Old lucerne, sown Oct., 1912 ..	12·26	12	6	2	26	1	0	0	11
	Young lucerne, sown Sept., 1913 ..	26·4	32	5	2	27	1	4	1	7
Second ... Dec. 9, 1914 ...	Old lucerne, sown Oct., 1912 ..	10·5	8	9	2	23	0	16	0	18
	Young lucerne, sown Sept., 1913 ..	23·5	15	11	0	0	0	13	0	0
Third ... Jan. 5-7, 1915 ...	Old lucerne, sown Oct., 1912 ..	8·19	9	6	0	24	1	2	2	25
	Young lucerne, sown Sept., 1913 ..	24·43	28	16	0	0	1	3	2	9
Fourth ... Feb. 8-13, 1915 ...	Old lucerne, sown Oct., 1912 ..	10·50	13	19	3	14	1	6	2	19
	Young lucerne, sown Sept., 1913 ..	28·77	23	9	2	29	1	0	2	6

Total yield of hay from 144.55 acres equals—

150 tons 4 cwt. 3 qrs. 22 lbs., or

20 $\frac{1}{2}$ cwt. per cutting, or

4 tons 3 cwt. per acre for season 1914-15.

Owing to the failure of the irrigation supply, the growth after the fourth cut was somewhat stunted and irregular. It was decided to utilize the area for grazing purposes for the rest of the season. On the area of 50 acres, comprising experimental and bull lucerne fields, a herd of 51 milking cows were grazed for six hours daily for 72 days. Seven foals were grazing continuously for 25 days, and 256 sheep continuously for a period of 22 days.

The grazing for the 50 acres, representing the value of the forage after the fourth cut had been taken, worked out in grazing units as follows:—

3,672 cow days.

175 foal days.

5,632 sheep days.

(2) Experimental Plots.

Variety Lucerne Trials.—Portion of the area of 15 acres sown in September, 1912, was devoted to variety plots to determine their value for hay production. During the 1913-14 season six cuttings were obtained. The first two cuts were not, however, weighed owing to lack of facilities and pressure of work. The remaining cuts were weighed, and they afford a fairly reliable indication of the value of the different varieties under conditions similar to those obtaining at Werribee.

These results are summarized in table:—

TABLE V.—*Showing Weight of Lucerne Hay Obtained from Variety Lucerne Plots, Werribee, for Two Years ending June, 1915*

Variety.	1st Cut.		2nd Cut.		3rd Cut.		4th Cut.		5th Cut.		6th Cut.		Average cut for season 1913-14.		1st Cut.		2nd Cut.		3rd Cut.		4th Cut.		Average cut for season 1914-15.	
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Arabian	164	264	231	87	194	141	9	167	22	15½	17½	17	17	17	17	17	17	17	17	17	17	17	17	17
French Province	163	257	247	93	19	29	131	183	33	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Turkestan	113	163	17	1	11	13	5	14	13	12½	12½	12	12	12	12	12	12	12	12	12	12	12	12	12
Pontian	132	23	19	8	16	15	94	162	16	14½	14½	15	15	15	15	15	15	15	15	15	15	15	15	15
Hungarian	161	229	205	8	17	104	111	227	211	18	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Spanish	12	12	18	21½	8	14½	9	17½	19½	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Tamworth	25½	261	25½	18	24	20	16	24	20	21½	21½	21	21	21	21	21	21	21	21	21	21	21	21	21

RATE OF SEEDING AND FERTILIZER TRIALS.

These formed part of an area of 35 acres sown with Tamworth lucerne in 1913. More time was available for the preparatory work than was the case of the area sown in 1912, and consequently the results, as judged by weight of crop produced, are rather better.

The paddock (35 acres) was seeded on 5th to 8th September, 1913, and during the first season yielded three cuts, which were utilized with other green foliage for silage purposes.

During the past season four cuts were obtained. Early in the season this lucerne field promised to give most prolific returns, but, owing to the failure through drought of the Pyke's Creek scheme, no irrigation water was applied from 24th September to 29th December—a period of over three months. The first cut was exceptionally heavy, being over 50 per cent. heavier than the corresponding cut for last season, but, owing to the failure of the water supply, due to the

droughty season, the second cut was grown without irrigation, and showed, as might have been anticipated, a considerable falling off. The timely irrigation on 29th December, and the favorable rain at Christmas-time, stimulated the third and fourth cuttings, but, as no further water was received after January, the season closed with the fourth cutting on 10th February. For the remainder of the season the whole of the experimental and bulk areas was grazed with milch cows and sheep as indicated above.

TABLE VI.—*Summarizing the Yield of Hay Obtained from the Rate of Seeding Trials, Fertilizer Trials, Inoculation and Liming Tests, Season, 1914-15.*

Details of Plot.	Oct. 9, 1914. 1st Cut.	Nov. 30, 1914. 2nd Cut.	Jan. 5, 1915. 3rd Cut.	Feb. 10, 1915. 4th Cut.	Total of 4 Cuts. 1914-15.
					Cwt.
(1) RATE OF SEEDING TRIALS.					
Plot 1, Tamworth lucerne, 6 lbs. per acre	32.3	18.4	26.3	26.0	103.0
Plot 2. " " 9 "	28.3	17.7	21.8	32.9	100.7
Plot 3. " " 12 "	34.0	17.5	28.3	27.25	107.0
Plot 4. " " 15 "	33.3	17.7	26.4	30.5	107.9
Plot 5. " " 18 "	34.5	17.4	25.3	32.3	109.4
Plot 6. " " 21 "	33.4	18.9	24.5	33.7	110.5
(2) FERTILIZER TRIALS.					
Plot 1. Lime 20 cwt., super 2 cwt., blood manure 1 cwt. ..	35.4	19.3	30.5	28.4	113.6
Plot 2. Lime 40 cwt., super 2 cwt. ..	28.3	16.0	30.7	29.2	104.2
Plot 3. Lime 20 cwt., stable manure 10 tons p.a. ..	34.6	21.3	27.1	26.0	109.0
Plot 4. Lime 20 cwt., super 2 cwt., nitrate soda 1 cwt. ..	37.5	15.4	35.6	30.6	119.1
Plot 5. Lime 20 cwt., super 2 cwt., sulphate pot. 1 cwt. ..	32.9	18.1	28.0	23.8	102.8
Plot 6. Lime 20 cwt. ..	35.3	15.3	26.2	27.0	103.8
Plot 7. Lime 20 cwt., bonedust 2 cwt. ..	31.7	18.8	27.2	30.1	107.8
Plot 8. Lime 20 cwt., Thos. phosphate 2 cwt. ..	34.2	15.2	27.5	27.3	104.2
Plot 9. Lime 20 cwt., super 2 cwt. ..	33.0	17.3	27.0	31.0	108.3
Plot 10. Ground limestone 36 cwt. ..	32.1	12.2	26.3	26.2	98.8
Plot 11. Nil ..	27.4	15.1	25.9	24.3	92.7
Plot 12. Super 2 cwt. ..	33.0	17.3	29.5	31.2	111.0
(3) INOCULATION AND LIMING TESTS.					
					Total for 4 Cuts. Cwt.
Plot 1. Not limed, not inoculated ..	33.1	10.9	26.9	28.6	99.5
Plot 2. Not limed, inoculated 1 ton lucerne soil ..	30.3	13.5	26.1	95.1	95.0
Plot 3. Not limed, inoculated 2 cwt. lucerne soil ..	28.5	15.1	26.2	29.2	99.0
Plot 4. Limed, not inoculated ..	29.1	10.5	26.4	28.8	94.8
Plot 5. Limed, inoculated 1 ton lucerne soil ..	30.0	13.7	26.0	28.9	98.6
Plot 6. Limed, inoculated 2 ton lucerne soil ..	31.7	13.7	26.1	26.4	97.9

COMMENT ON TESTS.

In carrying out the weighing and sampling of hay from these plots, the greatest care has been taken to obtain data for a uniform basis of comparison.

Every load of hay brought to the weighbridge was carefully sampled, and the samples immediately forwarded in hermetically sealed receptacles to the Agricultural Laboratory for the determination of the dry matter. The figures given in the tables represent the weight of hay reduced to the basis of commercial lucerne hay containing 85 per cent. of dry matter.

It is far too early to draw deductions from the results of the various plots, and the possible bearing of the results on practice. It will be time enough to draw such generalisations when more data has been accumulated. Meanwhile, there are features of interest in these tests that are worth pointing out, if only to see whether later experience will confirm or modify what now seems reasonably true.



Fig. 7.—Cutting lucerne with single horse mower to provide daily ration for Red Polled Dairy Herd, Werribee.

1. *Regarding the Prolificacy of Irrigated Lucerne at Werribee.*—No one would claim that the land on which this lucerne was grown was by any means ideal lucerne soil. Nor could it be said that the land is much better than the average irrigation land on the Werribee Estate. Yet the return from a 15-acre block averaged $6\frac{1}{2}$ tons of commercial hay in the second year of growth, besides providing considerable winter grazing for sheep. The yield for the third season exceeded 4 tons per acre, in spite of the fact that no water was received for irrigation purposes from 24th September to 28th December, 1914—a period of over three months. Moreover, after the irrigation extending from 28th December to 7th January the water supply was cut off, and no further water was available for the season. Had the water been available during this period, it is reasonable to expect that the yield for the third season would have considerably exceeded that of the second. Again, the average yields from the experimental plots (sown September, 1913) for the present season exceeded 5 tons per acre, though these plots only received three irrigations for the year.

From this it is apparent that irrigated lucerne sown under conditions similar to those at Werribee promises to be a most prolific and profitable crop, and the completion of the Exford weir should enable the Werribee Irrigation Estate to become a highly prosperous settlement.

2. Effect of Soil Inoculation.—With regard to the inoculation tests, a comparison of the six plots will reveal that during the second season of growth there is very little difference between the inoculated and the corresponding non-inoculated plots. The first year, however, the differences were very marked. One of the most striking ocular demonstrations at Werribee during the summer of 1912 was the difference in the appearance of four $2\frac{1}{2}$ acre blocks of lucerne, two of which were inoculated with lucerne soil from Bacchus Marsh, and two of which were not inoculated. As autumn and winter approached, the differences became less marked, and in the second season they had disappeared altogether. So with these smaller plots; at first the inoculated plots were a rich healthy green, and examination of the young roots



Fig. 8.—Thirty-five acre block of two year old lucerne, Central Research Farm, Werribee, season 1914-15.

showed that nodules were forming freely. The non-inoculated plots showed in the early stages a pale, yellowish, unthrifty appearance, but as the season wore on the difference between the plots gradually disappeared. It can only be surmised that the non-inoculated plots became slowly inoculated through the medium of the irrigation water as it flowed from plot to plot and from field to field, and this is borne out by the appearance of nodules on the non-inoculated plots in late autumn following the seeding.

The point to note, therefore, is that inoculation should not be necessary in a district where successful lucerne growing under irrigation has been carried on for a time, and that, in cases where lucerne has never been sown on a farm or in a district before, an effective inoculation of a relatively small area should soon lead to the inoculation of the whole area, by the carrying of the bacteria by air, dust, irrigation water, stock, and farm implements.

3. The Effect of Various Fertilisers.—The results of the fertiliser tests are of interest. It will be noted that by far the highest crops were obtained by using nitrogenous manures. In view of what has been said already regarding the ability of lucerne to obtain its nitrogen from the air, this may perhaps seem strange. But the explanation is simple enough. To secure the necessary nitrogen from the air, energy must be expended by the bacteria living on the lucerne roots, and by the lucerne in providing food for the bacteria. If you supply the nitrogen in the form of manure, or provide an excess of it in the soil, then the lucerne will prefer to use what is so supplied, instead of extracting it with the expenditure of more or less energy from the air.

Generally, it is not considered good farming practice to apply nitrogenous manures to a leguminous crop like lucerne. It is considered proper that the lucerne should be forced to obtain its nitrogen from the inexhaustible supplies in the air. But, if the farmer can secure a handsome profit by applying a nitrogenous manure to a legume is not he



Fig. 9.—Harvesting lucerne, Central Research Farm, Werribee.

justified in doing so? Examination of the results of the fertiliser trials will show that the plots dressed with nitrate of soda, blood manure and farmyard manure have yielded considerably in advance of the remaining manures.

If these plots continue to stand out prominently, the question of applying nitrogenous manures may become of immediate practical importance.

Effect of Phosphatic Manures.—It appears from the results of these preliminary tests that superphosphate is the most effective of the phosphatic manures in the early stages of the lucerne. It has given the best results where it has been applied by itself. When applied with lime the crop yields appear to be depressed, especially with heavier dressings.

Plot 11.—No manure, yield 92.7 cwt.

Plot 12.—Super., 2 cwt.; yield 111.0 cwt.

Plot 9.—Super., 2 cwt.; lime, 20 cwt.; yield, 108.3 cwt.

Plot 2.—Super., 2 cwt.; lime, 40 cwt.; yield, 104.2 cwt.

Probably the addition of lime has led to the reversion of the water soluble phosphate in the superphosphate to insoluble forms, and thus rendered the phosphates temporarily ineffective.

Lime.—So far as the action of lime is concerned, it appears that it has most immediate effect when applied as slaked lime. Thus, 20 cwt. of lime applied in the form of slaked lime has given a far better crop than 36 cwt. of ground limestone containing the same quantity of lime. Thus:—

- Plot 11.—No manure, 92.7 cwt.
- Plot 10.—Ground limestone, 36 cwt.; 96.8 cwt.
- Plot 6.—Lime 20 cwt.; 103.8 cwt.

This, of course, might possibly have been expected. Ground limestone acts very slowly on the soil, but its effect is nevertheless very lasting, and some time must elapse before its full effect becomes noticeable on the crop.

Rate of Seeding Trials.—The results of the rate of seeding trials emphasize how small a seeding may give a good stand, if the soil and weather conditions are favorable at the time of sowing. The six plots,

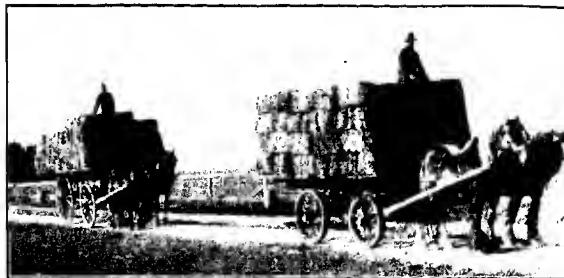


Fig. 10.—Carting baled lucerne hay to market.

varying in seeding allowances from 6-21 lbs., were sown on a very fine seed bed on 5th September, 1913. Several timely $\frac{1}{4}$ -inch showers, at intervals of a week, followed by good soaking rain, kept the surface moist, and gave a good germination. The plots sown with 6 and 9 lbs. per acre, while thoroughly satisfactory, have given slightly lower returns per acre, for the season, than the heavier seedings.

Sixteen pounds per acre is the allowance we have adopted in practice, and all areas seeded with this quantity have given excellent stands.

Weather and soil conditions, at the time of seeding, determine whether more or less than this average quantity should be sown.

SUMMARY.

1. Lucerne is one of the most valuable forages that can be grown on an irrigation farm.
2. The factors making for maximum yields of lucerne under irrigation conditions have been the subject of experimental investigation at Werribee.
3. These experiments comprise tests of (1) water requirements, (2) cultural requirements, (3) fertilizer requirements of lucerne.

4. A lucerne crop transpired approximately 681 tons of water to produce 1 ton of dry matter at Werribee for the season 1914-15.

5. By giving a lucerne crop as much water as it could use up during the season 1914-15, an equivalent of 8 tons 16½ cwt. of dry lucerne was produced per acre.

6. To produce this quantity, however, no less than 72 acre-inches of water were required, of which 61 acre-inches had to pass through the crop, and 11 acre-inches was dissipated from the soil by evaporation.

7. In field tests the water requirements of lucerne were even greater, on account of the impossibility of obtaining a perfect mulch, and thus keeping down the loss by evaporation from the soil.

8. On a block of 15 acres, sown in October, 1912, 12.3 tons of commercial hay, containing 10.45 tons of dry matter, were produced in 2½ years. During this period 9.1 acre-feet of water was supplied as rain and irrigation water.

9. Consequently, under field conditions, for every ton of dry hay produced at Werribee, 10½ inches of water were required, 3½ inches of which was lost from the soil by evaporation and 7 inches by transpiration.

10. An acre of lucerne in full growth will use up considerably more water than would be lost by evaporation from a free water surface of equal area.

11. The presence of a sufficiency of soluble phosphates helps to reduce the Transpiration Ratio, and this makes the crop more economical of water.

12. A 15-acre block of lucerne at Werribee yielded 6½ tons of commercial hay during the second season of growth; and 4.3 tons during the third season, though receiving only three irrigations during the past season.

13. Tamworth lucerne has given the best average yield during the past two years, averaging 22½ cwt. per acre for ten cuts.

14. The heaviest seedings of lucerne gave the best returns, but there appears to be no material benefit in sowing more than 18 lbs. of seed per acre. 16 lbs. is the seeding adopted at Werribee.

15. The application of artificial fertilizers gave decided and profitable increases over the unmanured plots.

16. Nitrogenous manures, though not generally used to fertilize leguminous crops, gave the most marked crop increases.

17. Superphosphate proved to be the most efficient of the artificial phosphates. An application of 2 cwt. at seeding, costing 9s., gave an increase of a ton of lucerne hay to the acre in the second season of growth, and this in spite of the dryness of the season.

18. Lime has given an increase in crop yields, but the increase was barely sufficient to cover the cost of the application. Heavier dressings than 20 cwt. appear to depress the yield. The effect of these manures will probably be felt next season.

19. Lime has given greater crop increases than an equivalent value of ground limestone, though the effect of the latter manure may be expected to persist longer.

20. In view of the heavy demands made on the mineral constituents of the soil by good lucerne crops, top dressings, applied every winter, of phosphates at the rate of 1½ to 2 cwt. per acre are recommended.

21. On soils similar to Werribee, dressings of lime or ground limestone, applied every two years, at the rate of 10-12 cwt. lime and 20-25 cwt. ground limestone are likely to prove profitable.

22. Inoculation of the soil with soil from an old lucerne field is recommended for localities where lucerne has never hitherto been grown. Once a small portion of the farm is so treated the remainder soon becomes inoculated through the moving of stock and implements, and through the agency of irrigation water.

**WOOL CLIP AND ESTIMATED TOTAL PRODUCTION—SEASON 1914-15
AND THE FOUR PREVIOUS SEASONS.**

Districts.	Wool Clip.		
	Sheep.	Lambs.	Total.
Central	5,140,421	366,296	5,506,717
North-Central	5,298,171	434,933	5,733,104
Western	23,322,568	1,728,321	25,050,889
Wimmera	10,597,726	756,520	11,354,246
Mallee	2,953,348	180,328	3,135,676
Northern	8,523,435	654,078	9,177,513
North-Eastern	4,415,567	444,701	4,860,268
Gippsland	4,752,069	520,420	5,272,189
Total Clip 1914-15	65,005,305	5,085,597	70,090,902
.. 1913-14	74,157,932	5,868,688	80,026,620
.. 1912-13	65,666,190	4,170,780	69,836,970
.. 1911-12	81,902,229	6,504,990	88,407,219
.. 1910-11	73,959,226	6,115,044	80,074,270
Average Weight of Fleece, 1914-15	6.37	2.16	5.58
.. 1913-14	7.50	2.35	6.46
.. 1912-13	6.31	2.20	5.68
.. 1911-12	7.28	2.33	6.29
.. 1910-11	6.99	2.50	6.15
Difference between 1914-15 and 1913-14—Decrease	1.13	0.19	0.88
Wool clip			70,090,902
Estimated quantity of wool stripped from Victorian skins and on Victorian skins exported			25,315,005
Total 1914-15			95,406,867

Note.—The total for 1913-14 was 106,833,690 lbs.; 1912-13, 88,762,612 lbs.; 1911-12, 110,463,041 lbs.; and 1910-11, 101,803,644 lbs.

The quantity of wool produced last season was worth approximately £3,410,913.

THE WALNUT.

(Continued from page 309.)

C. F. Cole, Orchard Supervisor.

PROPAGATION.

SOIL.

The most desirable soil for propagating the walnut in the nursery row is a medium heavy, easily-worked one, containing humus, and of a deep friable nature, well drained, having moisture-retaining properties.

Specially prepared and treated soils belonging to this class will produce trees of greater growth and vigour more quickly than soils of a light or sandy nature.

SOIL PREPARATION.

In the autumn, break up the land as deep as possible, the deeper the better, and reduce to a fine tilth. Plough in any farmyard or stable manure procurable. Work the land deep with a tooth cultivator before planting in early spring. When the soil is free from lumps, mark out the rows 4 feet apart; this will allow a small horse cultivator to be used in keeping the soil well stirred between the rows, as constant stirring of the soil should be practised around and about the young walnuts during their vegetative period. The seedlings also should not suffer from the want of soil moisture during the drier months, *i.e.*, if seedlings are to be raised the first twelve months sufficiently large for grafting purposes.

ROOTSTOCKS.

To allow the perpetuation of a choice or selected variety of walnut it is necessary to resort to grafting or budding to keep the type true. This is also the case if a large number of individual trees true to the parent type are required for planting a grove upon commercial lines.

To do this, use seedling rootstocks allied and with affinity to the scion or bud of the walnut required. The question of selecting suitable rootstocks is of great importance, and is to the future tree what a good foundation is to a house. Rootstocks should produce thrifty, vigorous, and productive trees, enabling them to be grown under many different conditions as regards soil and localities. A rootstock that may be suited for a certain class of soil under irrigation, or subject to wet conditions, may be unsuitable for drier soil conditions, and *vise versa*. What is desired is a good all-round rootstock, upon which the English walnut, when worked, will flourish, and one that is not easily affected by the unfavorable conditions which prevail at times in this State. The English seedling as a rootstock has been practically discarded in California; the nurserymen now use the indigenous black varieties of walnuts, and also hybrid seedlings raised from nuts. These hybrid nuts are secured from trees influenced by the exchange of pollen (fertilizing dust) between two species of walnuts growing in close proximity.

to one another. The cross between the American wild black species is named royal hybrids, and that between the black and English varieties is called paradox hybrids. The Californians find that the black and hybrid rootstocks will stand unfavorable conditions better than the English seedling. Selected English varieties, on the other hand, are more prolific, and generally come into bearing earlier than when worked upon their own seedlings. Some of these trees, five years planted in the grove, produced from 12 to 20 lbs. of nuts. Experiments were carried out in California by grafting the selected variety (Placentia perfection) upon different rootstocks such as the North Californian black, English, and Paradox. The result was in favour of the Paradox root, the tree at four years of age being twice as large as that upon the English root, and much larger than the tree upon the North Californian black root. All these trees were grafted and planted out at the same time, and were of uniform size, growing adjacent to one another, and under uniform conditions. That the production of nuts is proportionate to the size of the trees is shown by the crop of 1911; the tree upon the Paradox root produced $18\frac{1}{2}$ lbs., that upon the Northern Californian black root $12\frac{1}{2}$ lbs., and that upon the English root 9 lbs. (Bulletin No. 231). The writer has no doubt that the Californian black varieties will prove valuable for rootstock purposes in Victoria, because I have seen at Mr. J. M. Rutland's orchard, Kiewa, Victoria, numerous young trees, about six years of age, growing exceedingly well. Such trees have been planted with the object of utilizing them for timber. Although the hybrid rootstocks are highly spoken of in California, the royal hybrid being particularly adapted for wet and heavy soils, and even doing well upon drier soils, or without irrigation, there is very little likelihood of these hybrid rootstocks being largely used by the nurserymen there, owing to a very uncertain percentage of hybrid trees developing in the nursery from nuts gathered from trees subject to the influence of inter-pollinations, and, in addition, it requires a special knowledge to separate these hybrid roots from those of the straight black species.

Californian experiments seem to prove that only the first generation seedlings, that come directly from black walnuts which have been cross-fertilized with pollen of the English walnut in the Paradox, and royal hybrids, are suitable for rootstock purposes. The first generation of nuts some seasons produced from 40 to 50 per cent. of hybrids.

The second generation Paradox seedlings, that is, seedlings grown from nuts gathered from hybrid trees are unsuitable for the English varieties, such rootstocks producing trees lacking in any unusual vigour.

The whole question of the value of hybrid roots is, indeed, one concerning the progeny of individual special trees, rather than a matter of any general rules applying to all crosses between certain species. (Bulletin No. 231.)

The two black varieties of walnuts recommended in California as suitable for working the English varieties upon are as follows:—For wet soils or moist conditions, the Northern Californian (*Juglans Hindsii*), and for dry conditions and soils of a sandy nature the Southern Californian (*Juglans Californiae*). There should be no trouble in securing and importing nuts from California of these two black species for rootstock purposes.

When procuring nuts of any species for growing rootstocks, they should be secured from well-matured trees of a thrifty and vigorous habit. Culls should not be planted. Any seedlings that are not thrifty, or show a weakness in growth, should not be used for rootstock purposes. This is most important, as only scions or buds successfully worked upon the fittest rootstock can be expected to develop into vigorous and thrifty trees. In localities where the English walnut thrives upon its own roots, selected English seedlings as rootstocks may be used until such times as the black rootstocks have been proved. In soils or localities subject to adverse conditions, however, the writer does not recommend planting the walnut upon commercial lines if the trees are upon their own roots or worked upon English seedlings rootstocks. Guided by American experiences, the risk of failure should be greatly minimized if selected types of English walnuts worked upon either of the two species of indigenous American black varieties recommended as suitable for rootstock purposes are planted. The grower may rest assured that wherever the black species will thrive and make vigorous trees the English varieties will do well if worked upon them.

TREATMENT OF NUTS.

As soon as the selected nuts for planting have been harvested and dried (washing not being necessary) they should be put into old sacks and stored in a cool place, a damp atmosphere being preferred to a dry one. About July they should be placed in alternating layers of moist sand or some suitable compost made from decomposed straw, grass, or fallen leaves, mixed with decayed stable manure, or cow droppings, if available. The method adopted in California is to place the nuts in early winter in shallow wooden boxes containing two layers of nuts, and imbedding in sand or a suitable compost, finally covering the nuts with 3 to 4 inches of sand or compost, the bed being so constructed that water will easily drain away. If allowed to remain too wet, the nuts will rot. If too dry the nuts will not germinate. After placing the boxes in position, and covering them, water well, continuing to do so, if necessary, thus keeping the nuts well moistened, in order to start germination. The germinating bed should be so situated that it will receive the heat of the sun, and not be too cold for germination. The trays may be placed upon beds made from stable manure, covering them with sand afterwards. Nuts vary according to their species as regards their freedom of germination. The Southern Californian black sprouting earlier than other black walnuts, do not require to be kept so moist or placed in the germinating bed so early as the Northern Californian black or royal hybrid nuts. The latter require plenty of moisture and warmth to make them sprout, and if planted out into the ground before starting to germinate, may not sprout until the second or third year from planting. The Californian authorities recommend that in varieties which are hard to germinate the nuts should be placed in single layers in the box and kept well moistened, and as warm as possible, otherwise many of the nuts will not sprout the same year as planting. There is no difficulty in getting the English varieties to sprout if the nuts are sound.

(To be continued.)

RABBIT DESTRUCTION.

FRUIT AND CARROT POISONING.

By F. E. Allan, Chief Inspector, Vermin Destruction Act.

THE ART OF FREE-FEEDING.

All animals or birds that collect in any number have amongst them a proportion that rule or "boss" the others. This is specially so as regards the rabbit. When the "free-feed" is found, the stronger ones will take possession, and hunt or keep the others away till they have eaten their fill, and none may then be left to educate the balance. Any one who will take the trouble to lie in hiding and watch the freshly-laid furrows will see the stronger take possession, and hunt the weaker away. The next day, when it is found that all the feed is gone, most people merely relay the same quantity. This is again eaten by the same ones that had it before, and so on, till the poison baits are laid, when, of course, only those that have been "educated" are killed. The others have not had a chance to acquire the taste, and, as is most likely the case, if there are poisoned baits left in the furrows, it is just the same to them as if there had been no free-feeding at all. The rabbits only get to the baits because the stronger rabbits are killed, and certainly will not take the poisoned baits under such circumstances. If this were not so, what would be the object of free-feeding at all? It is, of course, plain that free-feeding means the partaking by the rabbits of a lot of baits, while only a very few are taken when poisoned. Now, the essence of the work is this:—When the free-fed baits are all taken (eaten) the first night, a far larger quantity must be laid the second time. If this is all eaten, then still more the third time. If still all is eaten, enough must be used to have some left in the morning, and then, if there is a good deal left, stand off for a night and let the rabbits clean it up before any poison is laid. The essential thing is to make sure that all the rabbits get the free-feed, and this can only be done by finding that some is left over. Practically a clean sweep can be done by this liberality. A man may get seven or eight hundred out of a thousand with insufficient free-feeding; but the man I want is he who can get the other two or three hundred, and this he can do by following out these instructions. Most land-holders stint both the free and poisoned baits—the most false economy possible. As a matter of fact, there is no need in free-feeding to study the distance between the baits where rabbits are plentiful. Simply scatter them along the furrow liberally. I have known places where rabbits are so thick that the same could be done with the poisoned baits, i.e., a rich flat, or such like, where they congregate for feed. It is hardly possible to err on the bountiful side; but very easy to be the other. Inspectors are instructed to study out and thoroughly follow the way I have laid down, and to impress the same strongly on all land-holders interested.

The wonderful results of the present methods are becoming more patent every day; and if failure follows the work, it can only be put down to one of two things—incapacity or indifference, with, of course, future trouble to follow.

**FIFTH VICTORIAN EGG-LAYING COMPETITION,
1915-1916.**

Commencing 15th April, 1915; concluding 14th April, 1916.

CONDUCTED AT THE BURNLEY SCHOOL OF HORTICULTURE.

Six Birds. Pen No.	Breed.	Owner.	Totals.			Position in Competition.
			15. 4. 15 to 14. 5. 15	15. 5. 15 to 14. 6. 15	Two months.	
			15. 4. 15	15. 5. 15	Two months.	

LIGHT BREEDS.

WET MASH.

19	White Leghorns	L. G. Broadbent	135	136	271	1
2	"	E. A. Lawson	124	120	244	2
33	"	W. G. Swift	104	140	244	3
34	"	H. McKenzie and Sons	105	138	243	4
6	"	J. Schwab	125	115	240	5
9	"	C. J. Jackson	112	120	238	6
8	"	E. B. Harris	113	124	237	7
2	"	Marsville Poultry Farm	116	120	236	8
7	"	A. E. Silbereisen	123	109	232	9
30	"	G. McDonald	101	130	231	10
38	"	W. M. Bayles	92	135	237	11
42	"	H. C. Brock	101	122	223	12
60	"	N. Burton	120	93	222	13
5	"	J. J. West	103	117	220	14
16	"	A. A. Sandland	115	103	218	15
52	"	A. W. Hall (5 birds)	114	102	215	16
33	"	D. Adams	126	85	211	17
18	"	F. Hodges	96	114	210	18
32	"	R. Hay	103	107	210	19
4	"	Giddy and Son	97	112	209	20
25	"	W. M. Sewell	118	89	207	21
39	"	A. H. Mould	109	97	206	22
51	"	A. Mowat	109	97	205	23
26	"	Mr. M. M. Oliver	98	107	204	24
44	"	J. E. Thirkell	94	110	203	25
10	"	J. E. Gill	84	117	201	26
3	"	Mrs. M. Stevenson	96	95	194	27
1	"	Waldron Poultry Yards	101	93	193	28
36	"	B. Mitchell	94	89	181	29
53	"	R. Lethbridge	88	91	179	30
28	"	H. N. H. Mirams	63	113	176	31
15	"	John Hood	70	106	176	32
50	"	C. J. Beatty	79	90	169	33
48	"	Fulham Park	88	73	167	34
49	"	C. C. Dunn	57	110	167	35
21	"	J. B. Dridgen	85	80	165	36
43	"	H. L. Merrick	71	92	163	37
47	"	J. C. Armstrong	56	105	161	38
46	"	R. Berry	92	68	160	39
49	"	Bennett and Chapman	99	60	159	40
24	"	Lysbeth Poultry Farm	49	110	159	41
23	"	R. W. Pope	70	86	156	42
59	"	W. G. Osborne	66	89	155	43
55	"	W. N. O'Ullian	89	65	154	44
13	"	J. Hustler	57	97	154	45
22	"	S. Boulton	65	88	153	46
17	"	Miss E. Zimmerman	93	58	151	47
54	"	W. G. Ulligan	83	69	151	48
14	"	W. Flood	64	87	151	49
12	"	G. Hayman	56	88	144	50
45	"	South Yar Yeaw Poultry Farm	59	82	141	51
58	"	Thirkell and Smith	87	30	117	52
41	"	J. A. Donaldson	87	74	112	53
37	"	A. Ross	53	44	97	54
81	"	L. McLean	60	36	96	55
56	"	C. Hurst	47	48	95	56
27	"	J. A. Stahl	5	85	90	57
		Total	5,075	5,554	10,629	

FIFTH VICTORIAN EGG-LAYING COMPETITION, 1915-16—continued.

Six Birds. Pen No.	Breed.	Owner.	Totals.				Position in Competition.
			15.4.15	15	15	Two months.	
			to 14.5.15.	to 14.6.15.	14.6.15.		

LIGHT BREEDS.

DRY MASH.

80	White Leghorns ..	W. H. Robbins ..	126	154	280	1
66	" ..	E. A. Lawson ..	134	106	240	2
79	" ..	Lysbeth Poultry Farm ..	113	120	233	3
64	" ..	W. M. Bayles ..	122	107	229	4
72	" ..	Mrs. E. Zimmerman ..	131	93	224	5
68	" ..	H. McKenzie and Son ..	83	130	213	6
69	" ..	E. MacBrown ..	92	115	207	7
78	" ..	H. Bamforth ..	90	143	193	8
62	" ..	Benwerren Egg Farm ..	123	60	183	9
65	" ..	Thirkell and Smith ..	123	48	171	10
67	" ..	C. C. Dunn ..	59	81	140	11
76	" ..	A. J. Scotland ..	95	68	163	12
71	" ..	Moritz Bros. ..	49	106	153	13
63	" ..	A. A. Padman ..	86	37	123	14
77	" ..	South Yarra Poultry Farm ..	18	57	75	15
61	" ..	Mrs. H. Stevenson ..	28	43	71	16
75	" ..	Fulham Park ..	9	60	69	17
74	" ..	J. H. Gill ..	18	43	61	18
73	" ..	C. L. Lindrea ..	29	5	34	19
Total			1,558	1,536	3,094	

HEAVY BREEDS.

WET MASH.

81	Black Orpingtons ..	Mrs. T. W. Pearce ..	143	132	275	1
100	" ..	J. H. Wright ..	111	159	270	2
97	" ..	Marville Poultry Farm ..	135	106	241	3
94	" ..	D. Fisher ..	113	114	227	4
90	" ..	Oaklands Poultry Farm ..	88	139	227	
96	White Orpingtons ..	Stranks Bros. ..	93	111	204	6
88	Black Orpingtons ..	J. McAllan ..	94	105	199	7
85	" ..	H. H. Pump ..	78	114	192	8
90	" ..	L. McLean ..	70	115	185	9
91	" ..	A. Greenhalgh ..	83	99	182	10
86	" ..	C. E. Graham ..	48	133	181	
89	Rhode Island Reds ..	E. W. Hipp ..	63	118	181	11
87	Black Orpingtons ..	W. G. Spencer ..	72	100	172	13
95	Silver Wyandottess ..	J. H. Forsyth ..	74	89	163	14
84	Black Orpingtons ..	Cowan Bros. ..	28	100	137	15
83	" ..	G. Mayberry ..	57	69	126	16
93	" ..	L. W. Parker ..	14	24	108	17
92	" ..	J. O'Brien ..	21	45	66	18
98	Faverolles ..	K. E. Courtney ..	—	38	38	19
82	White Wyandottess ..	J. B. Bridgen ..	—	—	—	20
Total			1,385	1,902	3,277	

MONTHLY REPORT.

Weather conditions for the past month were, on the whole, seasonable. Cloudy weather, with much rain chiefly obtained, with intervals of bright sunshine and occasionally high winds. Temperatures were generally low. The egg yield for time of year has been good, some especially good scores being put up by the heavy breeds. Broodies numbered twenty-five for the month, including four Leghorns. Rainfall, 442 points.

Department of Agriculture,
Melbourne, Victoria.

A. HART,
Chief Poultry Expert.

ORCHARD AND GARDEN NOTES.

E. E. Pescott, F.L.S., Principal, School of Horticulture, Burnley.

The Orchard.

PRUNING.

In pruning the young trees, heavy pruning will be required in order to produce strong growth and a good frame; but as the tree advances in age, the pruning will be reduced considerably. It should be remembered that strong, heavy pruning results in wood growth, and that weak pruning steadies the tree and promotes an even growth. When framing and building a tree, the former consideration is observed, and when the tree is coming into fruit bearing or is mature, it will be pruned according to the latter. Any operation that will cause the tree to produce less wood growth will induce the tree to become more fruitful, provided the tree is in a healthy condition; so, when the trees are mature, pruning operations, as a rule, should not be severe, but rather the reverse.

Where varieties of fruit trees are prone to bearing crops every second year, their lateral system should be so pruned that they will not produce too heavy a crop in the fruiting year; and at the same time produce wood in their fruiting year to give a crop the subsequent season.

A model tree will always be light on its topmost leaders, bearing the major portion of the crop in the lower regions of the tree. The main point to be noted is that a heavy wood growth in the upper portion of the tree tends to reduce the bearing capabilities of the tree in its most useful parts.

SPRAYING.

Spraying should be carried out on the lines indicated in last month's notes, and it should be completed by the end of the month.

PLANTING.

The planting of deciduous fruit trees will still be continued on the lines laid down in last month's notes. Care should be taken to have the soil thoroughly sweetened and aerated, the roots should be well trimmed, and the young tree firmly planted. Owing to the time that elapses between the removal of the tree from the nursery row and the planting of the tree in its permanent situation, practically the whole of the fibrous and feeding root system has been destroyed. It will be well to remove all of the finer roots, and to thoroughly trim back the stronger ones. This will allow the tree to make a new root system for itself.

In planting a commercial orchard, it has been previously advised that the number of varieties should be limited, and that, as far as possible these varieties should have a corresponding bloom period. The necessity for cross-fertilization is becoming more apparent every year, and it is now definitely known that cross-fertilization results in greatly increased crops, and also in fruit of an increased size. In the experiments of Waite, on the "Pollination of Pear Flowers," and of Lewis and Vincent, on "The Pollination of the Apple," their results were invariably that the largest fruits were crosses. Fruit-growers in this State have observed that where blocks of different varieties of the same

kind of fruit have been planted alongside of each other, the adjoining rows of the two varieties have always carried the heaviest crops. Experience is thus against the planting of large blocks of any one variety; at the same time the varieties must not be multiplied indefinitely. The Jonathan apple is generally considered to be a consistent bearer and self-fertile; but even this prolific variety may be made to largely increase its yield by intermingling with another variety having a similar bloom period; and it has been found that the Sturmer Pippin is one of the best for the purpose. Dumelow's Seedling, Reinette du Canada, and Stone Pippin also flower at the same time. For fuller information on this subject, reference may be made to the articles in the *Journal* for January, 1911.

The Vegetable Garden.

The addition of gypsum to the vegetable plots prior to digging will rid the soil of a large number of insects that infest the vegetables in spring, and thus numbers of vegetable pests, such as caterpillars, aphis, &c., will be killed. The gypsum may be dug into the soil at the rate of about 2 ozs. to the square yard. Another trouble in the vegetable garden at this season of the year is the snail and slug pest. The article on slugs and snails in the December, 1910, *Journal* may be consulted, but one means of reducing this pest is to keep the plot free from weeds. As hoeing is generally out of the question in winter, the weeds should be hand-pulled. Where any foliage is in direct contact with the ground, it should be lifted occasionally, and a light dusting of lime sprinkled underneath. All seedlings of sufficient size should now be planted out; this includes onions, asparagus, lettuce, cabbage, cauliflower, &c. A planting of broad beans may be made, and also all varieties of peas. Seeds of summer cabbage, lettuce, leeks, onions, radish, parsnip, may now be sown. Tubers of Jerusalem artichokes should be planted out, and also a few early potatoes. Seeds of tomatoes may be planted in the frames, and also, towards the end of the month, seeds of melons, cucumbers, marrows, pumpkins, may be sown under glass in the hot bed.

The Flower Garden.

THE IRIS.

A section of garden plants that is increasing in popularity is the iris family. It is usually accepted that irises produce their flowers in Spring and early summer. There is a certain amount of truth in this, because the bulk of the iris varieties bloom at those times. This is notably so in regard to the German section and its allies, to the Japanese, and also to the bulbous irises of the Spanish and English sections. The new Dutch irises, too, flower in spring and summer. The first iris to bloom is a most charming one, of rich, metallic blue colour, each of the falls having a central stripe of gold. This is *Iris alata*, and is known as the Scorpion iris. It has thick fleshy roots, and should be allowed to remain in the same place permanently. The Scorpion iris flowers in April, May and June. Following this comes that beautiful heliotrope iris which flowers from May to September, *Iris stylosa*. This is one of the most useful plants for winter flowers, as the established clumps produce great abundance of blooms. The flower buds should be

gathered every day, and placed in water in the house, when they will open freely. There are several varieties of this iris, ranging from white and heliotrope almost to purple. The next section to flower is *Iris germanica*, of which with its relations many hundreds of beautiful varieties are now grown. This is the section known as Flag irises. Such varieties as Madame Chereau, Innocenza, Kharont, Mrs. H. Darwin, Victorine, and Miss Maggie are all very beautiful, while Jacquiniana and Iris King are two of the most beautiful forms, almost red, that have been grown.

A variety flowering in early spring, and belonging to the bulbous section is *Iris tingitana*. This has beautiful blue flowers, carried on long stems, and is very distinct in appearance. The flowers are somewhat like the Spanish section, but they are much larger. The whole of the irises previously mentioned are fond of lime.

The Japanese iris, or *Iris Kempferi*, is one of the most beautiful sections, and the plants produce flowers in great abundance, mainly in early summer, and occasionally a few odd blooms in late summer. This is also the case with some of the German irises.

The Japanese iris is a lime-hater, and no lime whatever must be given to it. It has been usually accepted that this iris must be grown in mud, or at least with abundance of water. This is quite wrong, as any of the Japanese irises, and there are many beautiful varieties, will flower in a good loamy soil among other plants in the flower border, provided a reasonable amount of water is given. Other summer-flowering irises are *Iris ochroleuca*, and *Iris Monieri*, and *Iris aurea*. These are evergreen, growing in clumps with long leaves, the flowers being carried on long stems, which are frequently from 3 to 4 feet in height. The first-named is white and gold, the second yellow, and the third golden-coloured.

The Spanish and English irises, and also the new Dutch iris family, belong to the bulbous section which flowers in spring and early summer, and which lose their leaves in the winter. These are very fine, grown in clumps, and many colours and shades, ranging through browns, purples, yellows, blues, and whites, are to be obtained.

GENERAL.

Digging in the garden should be continued. Before digging, the beds should be given a top dressing of lime or stable manure, and subsequently these should be dug well into the soil. Care must be taken not to injure the roots of any shrubs, trees, or roses. Root cutting and root pruning will always dwarf any plant. In digging, it is not wise to discard any leaves, twiggy growths, or weeds. Unless they are required for the compost heap, they should always be dug into the soil. Leaf-mould is especially useful in any garden, and where such plants as azaleas, rhododendrons, lilies, &c., are grown, or for pot-plant work, it is exceedingly valuable. In forming the compost heap, no medium whatever should be added to help the rotting down of the leaves unless it be a little sand. Any chemical added will render the mould unsuitable for its special objects.

All shrubs that produce flowers on their young growths, including roses, should now be pruned. Care should be taken to distinguish between those shrubs that flower on the new wood and those that flower

on the wood of the past season's growth. Those that flower on the new wood, and may now be pruned, are *Lasianandra*, *Lantana*, *Cestrum*, *Tecoma*, *Hydrangea*, *Plumbago*, *Erythrina* (some species), &c., and those that should not be touched at present are *Spiraea*, *Erythrina* (some species), *Pyrus Japonica*, *Weigelia*, *Prunus pissardi*, *P. Vesuvius*, *P. mume*, *Deutzia*, *Polygalas*, *Ceanothus*, &c. It is a safe rule in pruning shrubs to wait until they have flowered before pruning. This will certainly give the shrubs a somewhat ragged and untidy appearance in the winter, but it is the only way to secure the best flowering results.

All herbaceous plants, such as salvia, aster, delphinium, polygonum, boltonia, gaura, and erysanthemum, should be cut back, and, if necessary, lifted and heeled in a temporary location for the winter. Plant out gladioli, iris, and lilliums.

Continue digging, manuring, and trenching.

COMPARATIVE VALUES OF STOCK FOOD.

The best way to estimate the comparative value of the different food stuffs available is on the basis of current price per unit of food nutrients. This is arrived at in the following manner:—

Percentage of protein, plus fat multiplied by $2\frac{1}{2}$, plus carbo hydrates, divided into market price.

EXAMPLE.

Liaised Oilcake.

			Market price per ton.
			£ s. d.
Protein	..	$26\cdot1\%$	$= 32\cdot6 \times 2\frac{1}{2} = 81\cdot5$ food units
Fat	..	$6\cdot5\%$	
C.H.	..	$38\cdot5\%$	$\dots 38\cdot5$
			$\overline{120\cdot0}$ food units
Usual market price	..	..	$12\ 0\ 0 = 2s.$ per unit. $11\ 0\ 0 = 1s. 10d.$ per unit.

Bran.

Protein	..	$11\cdot2\%$	$\{ = 13\cdot7 \times 2\frac{1}{2} = 34\cdot25$ food units
Fat	..	$2\cdot5\%$	
C.H.	..	$42\cdot2$	$\dots 42\cdot2$
			$\overline{76\cdot45}$ food units
Usual market price	..	..	$10\ 5\ 0 = 2s. 8d.$ per unit. $5\ 0\ 0 = 1s. 3\frac{1}{2}$ per unit.

Oaten Hay.

Protein	..	$4\cdot2\%$	$\{ = 6\cdot0 \times 2\frac{1}{2} = 15\cdot0$ food units
Fat	..	$1\cdot5\%$	
C.H.	..	$43\cdot7\%$	$\dots 43\cdot7$
			$\overline{58\cdot7}$ food units
Usual market price	..	..	$10\ 0\ 0 = 3s. 5d.$ per unit. $2\ 10\ 0 = 10\frac{1}{2}d.$ per unit.

Molasses.

Protein	..	7%	$\{ = .84 \times 2\frac{1}{2} = 2\ 10$ food units
Fat	..	$.14\%$	
C.H.	..	$53\cdot68$	$\dots 53\cdot68$
			$\overline{55\cdot78}$ food units
			$8\ 0\ 0 = 2s. 10\frac{1}{2}d.$ per unit.

Food Contents of Foods Available.

			Protein.	Carbo hydrates.	Fat.
HAY—					
Lucerne	..	..	12·3	37·1	1·6
Oat	..	..	4·5	43·7	1·5
Rye Grass	..	..	6·1	37·8	1·2
Taro	..	..	12·9	37·5	1·4
Wheat	..	..	3·6	46·1	1·1
STRAW—					
Barley	..	..	·7	41·2	·6
Oat	..	..	1·2	38·6	·8
Pea	..	..	4·3	32·3	·8
Wheat	..	..	·4	36·3	·4
GRAIN—					
Barley	..	..	9·6	63·5	2·1
Maize	..	..	7·8	66·7	4·3
Oats	..	..	9·2	47·3	4·2
Wheat	..	..	13·7	47·6	1·4
PRODUCTS—					
Brewer's Grains	..	..	3·9	9·3	1·4
Cocoonut Oilcake	..	..	16·4	42·2	9·1
Linseed Cake	..	..	26·1	38·5	6·5
Malt Combings	..	..	26·1	50·6	1·5
Oat-Branning	..	..	9·6	54·1	5·5
Bran	..	..	11·2	42·2	2·5
Pollard	..	..	12·2	53·4	3·8
ROOTS, ETC.—					
Beet Pulp	..	..	·6	7·3	·0
Sugar Beet	..	..	1·6	11·9	·1
Cabbage	..	..	1·8	8·2	·4
Carrots	..	..	·8	7·8	·2
Mangolds	..	..	1·1	5·4	·1
Pio Melon	..	..	·7	3·5	·6
Pumpkins	..	..	1·0	5·8	·3
Turnips	..	..	1·9	7·2	·2
Potatoes	..	..	·9	16·3	·1

PIG FEED.

As pig feed of all descriptions is now so high in price the following will be a guide as to whether pork can be profitably raised. The price of all meat is likely to be high for some time to come:—

BASING THE VALUE OF CARCASS PORK AT 6D. PER POUND.

Amount of food required to produce a lb. of pork.	Lbs. of feed.	Will produce lbs. of pork.	Value per gallon, ton, or bushel.	Value of food per lb.
30 lbs. Skim milk	..	1	2d. per gallon	..
29 .. Potatoes	..	2·240	56s. per ton	3d.
5 .. Barley	..	50	5s. per bushel	1·2d.
5 .. Oats	..	40	4s. per bushel	1·2d.
5 .. Wheat	..	60	6s. per bushel	1·2d.
5 .. Pollard	..	20	4s. per bushel	1·2d.
5 .. Maize	..	56	5s. 6d. per bushel	1·2d.

Lucerne should be made more use of for pig feed. It has been proved by experiment that lucerne cut when just coming into bloom 2½ lbs. is equal to 1 lb. of grain. If cut late it takes 6 lbs. to equal

1 lb. of grain. Practically only the leaf is of value for pigs, the stalk being too fibrous. The lucerne chaffed should be mixed with grain feed and soaked for twelve hours or more.

REMINDERS FOR AUGUST.

Live Stock.

HORSES.—Those stabled can be fed liberally. Those doing fast or heavy work should be clipped; if not wholly, then trace high. Those not rugged, on coming into the stable at night should be wiped down and in half-an-hour's time rugged or covered with bags until the coat is dry. Old horses and weaned foals should be given crushed oats. Grass-fed working horses should be given hay or straw, if there is no old grass, to counteract the purging effects of the young growth. Old and badly-conditioned horses should be given some boiled barley.

CATTLE.—Cows, if not housed, should be rugged. Rugs should be removed in the day-time when the shade temperature reaches 60 degrees. Give a ration of hay or straw, whole or chaffed, to counteract the purging effects of young grass. Calves should be kept in warm, dry shed. Those on the bucket should be given their milk warm. The bull may now run with the cows.

PIGS.—Supply plenty of bedding in warm, well-ventilated styes. Keep styes clean and dry, and the feeding troughs clean and wholesome. Store pigs should be placed in fattening styes. Sows in fine weather should be given a grass run.

Sheep.—Ascertain what Merino and Lincoln rams will be required for the coming season, and apply to breeders this month. Cull stud ewes carefully, retain only the very best, pedigree alone is not sufficient, individual merit as well must be considered, the one is inseparable from the other. Market any aged fat ewes that have missed rearing a lamb, prices are unprecedented, no need to be prime mutton. Unless holdings are of insufficient area all best early born ewe lambs should not be sold for slaughter. Good ewes will be practically unprocurable later. Retain all good ewes under four years old.

Poultry.—Yards should be turned over with a spade or fork, and sown down with rape or barley. Keep the breeders busy—straw litter with little grain scattered about will make them exercise. Overhaul incubators; see that the capsule or thermostat acts properly; thoroughly clean lamps, egg drawers, and chimneys. Test machine for two days before putting eggs in. It is also advisable to have thermometer tested. When additional incubators are required, it is more satisfactory to keep to the one make.

Cultivation.

FARM.—Second fallow where necessary for summer crops. If required, roll or harrow crops. Plant very early potatoes in forward districts. Sow mangolds. Apply slow-acting fertilizers, such as blood and bone manures, for maize.

ORCHARD.—Complete planting and pruning of deciduous trees. Watch for peach aphids, and spray with tobacco solution, if present. Prepare for planting citrus trees. Spray for woolly aphids with lime sulphur spray.

FLOWER GARDEN.—Finish digging and pruning of roses, &c. Leave pruning of shrubs till after flowering. Keep weeds in check; weed out seed beds. Divide and plant out all herbaceous plants, such as phlox, delphiniums, rudbeckia, &c. Plant out gladioli. Complete planting of shrubs. Mulch young plants.

VEGETABLE GARDEN.—Top-dress asparagus beds; plant new asparagus plots. Plant herb divisions, and potatoes. Sow cabbage, cauliflower, peas, carrots, beans, radish, and lettuce seeds. Sow tomato seeds in a hot frame. Finish digging.

VINEYARD.—August is the best month for planting vines (grafted or ungrafted). This should be actively proceeded with and completed before end of month. Scions for field grafting may still be preserved as detailed last month, or better still by placing them in cool storage. They should all be removed from vines before end of month, at latest. Conclude pruning and tie down rods. Where black spot has been prevalent, apply 1-lt acid iron sulphate treatment (see *Journal* for July, 1911). Apply readily soluble nitrogenous manures (soda nitrate or ammonium sulphate) during this month.

Cellar.—Rack again, towards end of month, wines which have as yet only been once racked (spring racking). Fill up regularly all unfortified wines. Clean up generally in cellar and whitewash walls, woodwork, &c.